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WITH INDEXES

Supplement 31

MAY 1973

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 31

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in April 1973 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 307 reports, journal articles, and other documents originally announced in April 1973 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes—subject, personal author, and contract number—are included.

An annual cumulative index will be published.

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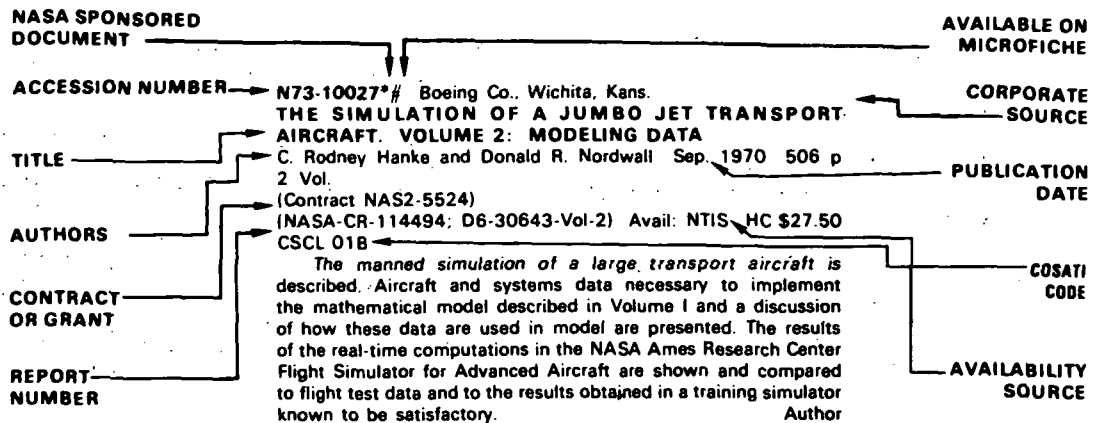
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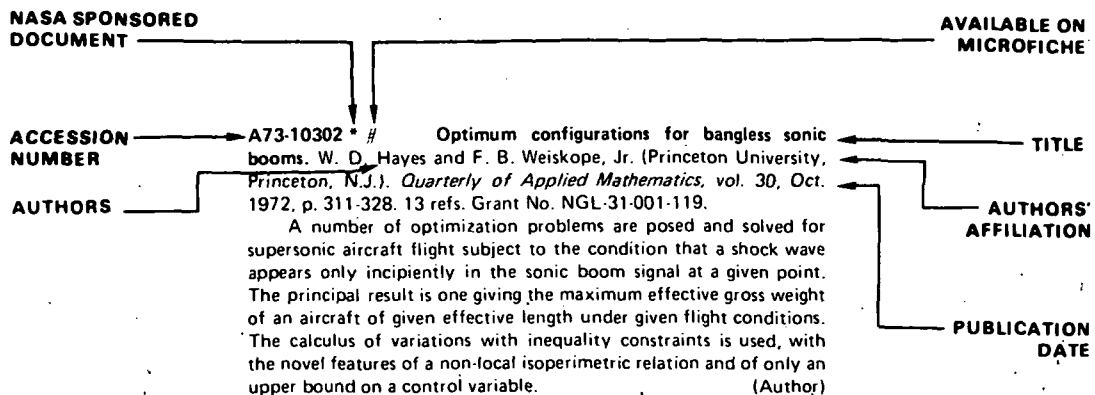
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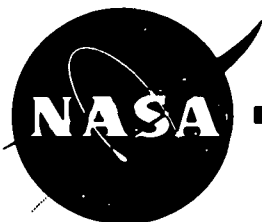
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TYPICAL CITATION AND ABSTRACT FROM IAA





AERONAUTICAL ENGINEERING

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IAA ENTRIES

A73-18899 Systems for collision avoidance. J. H. Reed (U.S. Department of Transportation, National Transportation Safety Board, Washington, D.C.). (*Air Traffic Control Association, Annual Meeting, 17th, Chicago, Ill., Oct. 8-11, 1972.*) *Journal of Air Traffic Control*, vol. 15, Jan.-Feb. 1973, p. 5-7.

Evaluation of midair collision accident data and near collision data over the past several years indicates that there is no single remedial solution to the midair collision hazard. Assessments indicated that 49% of the accidents could have been avoided if all aircraft had been radio equipped and adhered to improved procedures requiring mandatory position calls in the vicinity of uncontrolled airport areas. It was also indicated that 24% of the accidents could have been avoided if there had been published standard traffic patterns at all airports. F.R.L.

A73-18900 Ground based CAS versus Airborne CAS. R. E. Erickson (Honeywell, Inc., Minneapolis, Minn.). (*Air Traffic Control Association, Annual Meeting, 17th, Chicago, Ill., Oct. 8-11, 1972.*) *Journal of Air Traffic Control*, vol. 15, Jan.-Feb. 1973, p. 10-13.

It is considered that there is a growing need for air-derived collision prevention systems in airspace that is not under positive control. Honeywell's interrogator/transponder concept has been proven in the operation and flight evaluation of systems delivered to the U.S. Army. An operational pilot warning indicator, a tested, advanced proximity warning indicator which includes relative bearing information, and a prototype collision warning system which has successfully undergone an extensive Army flight evaluation are described. Any system within this family of devices will communicate and function operationally with any of the others. F.R.L.

A73-19088 Damping configurations that have a stabilizing influence on nonconservative systems. G. T. S. Done (Edinburgh, University, Edinburgh, Scotland). *International Journal of Solids and Structures*, vol. 9, Feb. 1973, p. 203-215. 15 refs.

A73-19097 Analysis of internally generated sound in continuous materials. III - The momentum potential field description of fluctuating fluid motion as a basis for a unified theory of

internally generated sound. P. E. Doak (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 26, Jan. 8, 1973, p. 91-120. 5 refs. Contract No. F33615-71-C-1663.

A73-19099 * The status of engineering knowledge concerning the damping of built-up structures. E. E. Ungar (Bolt Beranek and Newman, Inc., Cambridge, Mass.). *Journal of Sound and Vibration*, vol. 26, Jan. 8, 1973, p. 141-154. 35 refs. Contract No. NAS1-9557-17.

The importance of the effects of structural joints on the damping of built-up structures is pointed out, and the energy dissipation mechanisms associated with squeezing, rocking, and shearing motions are discussed for simple joints that are dry, lubricated, or provided with viscoelastic inserts. The damping mechanisms and behaviors of built-up beams and of skin-stringer structures are discussed as far as they are currently understood, and available damping estimation methods are summarized. Difficulties in defining and measuring the damping of skin-stringer structures are indicated, and it is pointed out that particularly the high-frequency damping of built-up beams and the low-frequency damping of skin-stringer configurations require further investigation. (Author)

A73-19141 # The Aeronautical Satellite Programme - ATC aspects. M. O'Hagan (Plessey Radar, Ltd., Weybridge, Surrey, England). (*British Interplanetary Society, Symposium on Communications Satellites, University of Southampton, Southampton, England, Sept. 19, 20, 1972.*) *British Interplanetary Society, Journal*, vol. 26, Feb. 1973, p. 90-96.

In this paper the current practice in oceanic Air Traffic Control (ATC) is reviewed, the facilities offered by the Aerosat system are discussed, and some of the operational effects of its introduction are identified. (Author)

A73-19182 # Collection and processing of data for the establishment of route charges. L. Putz. *Eurocontrol*, vol. 2, no. 6, 1972, p. 4-8. Translation.

A73-19183 # The experimental data processor. W. D. Miller. *Eurocontrol*, vol. 2, no. 6, 1972, p. 9-12.

Description of an experimental data processor intended as a test bed on which the concepts implied by ATC systems could be proven both technically and operationally. This data processor is a scale working model of a semiautomatic digital ATC en route control system and incorporates most advanced computer techniques. A two-level concept of main processors and display processors is employed. The task of the main processors is to create and maintain up to date an internal image of the total ATC system in the form of a data bank using plan, radar, and associating plan/radar logics. The

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display processors act, on the one hand, as the display message filter and switching system ensuring that the data are steered to the correct controller at the correct time, and, on the other, as the handler of controller input commands for system control purposes. A.B.K.

A73-19184 # Automated radar terminal systems (ARTS). A. R. Ridenour. *Eurocontrol*, vol. 2, no. 6, 1972, p. 22-25.

Description of the design and operation of a new automated radar terminal system (ARTS III) which simplifies the acquisition and maintenance of radar identification of aircraft on the radar display and provides the controller with beacon-derived altitude data to help reduce verbal coordination and communications workload. In the basic ARTS III beacon-tracking level system, individual tags of alphanumeric data are written on the controller's display. The tags are kept tied to their appropriate beacon target by the computer tracking program. Communication from the controller to the ARTS III computer is accomplished with data entry devices provided at each control position. The actual sequence of operation with ARTS III is described, and numerous improvements in the conditions of air traffic control at Chicago's O'Hare International Airport since ARTS III became fully operational at that facility are noted. A.B.K.

A73-19188 * # Approximate analysis of containment/deflection ring responses to engine rotor fragment impact. R. W. H. Wu and E. A. Witmer (MIT, Cambridge, Mass.). *Journal of Aircraft*, vol. 10, Jan. 1973, p. 28-37. 21 refs. Grant No. NGR-22-009-339.

The transient responses of containment and/or deflection rings to impact from an engine rotor-blade fragment are analyzed. Energy and momentum considerations are employed in an approximate analysis to predict the collision-induced velocities which are imparted to the fragment and to the affected ring segment. This collision analysis is combined with the spatial finite-element representation of the ring and a temporal finite-difference solution procedure to predict the resulting large transient elastic-plastic deformations of containment/deflection rings. Some comparisons with experimental data are given. (Author)

A73-19189 * # Hypersonic flows in large-scale inlet models. W. R. Seebaugh (Fairchild Industries, Inc., Farmingdale, N.Y.). *Journal of Aircraft*, vol. 10, Jan. 1973, p. 38-44. 9 refs. Contracts No. NAS2-5052; No. NAS2-5719.

Analytical and experimental investigations were conducted to determine the characteristics of the internal flows in model passages representative of inlets for a typical Mach 12 hypersonic cruise vehicle and also sufficiently large for reliable data to be obtained. Three large-scale inlet models, each having a different internal compression ratio, were designed to provide maximum performance at the throat stations. Tests were conducted in the Mach 7.4 nozzle of the NASA Ames 3.5-foot hypersonic wind tunnel at a nominal test Reynolds number of 2,700,000 per ft. The experimental results revealed that a high level of total pressure recovery, approximately 0.85 (relative to the inlet-entrance conditions) for the core flow of the internal passage, was achieved for each inlet design. (Author)

A73-19191 * # Model tests on unsteady rotor wake effects. K. H. Hohenemser and S. T. Crews (Washington University, St. Louis, Mo.). *Journal of Aircraft*, vol. 10, Jan. 1973, p. 58-60. 6 refs. Contract No. NAS2-4151.

A qualitative model of unsteady asymmetric wake effects is considered, taking into account a progressing blade flapping mode in which each blade flaps in a rotating frame of reference. The rotor model used for the tests is two bladed. The experimental data are compared with an analytical flapping response. It is found that the

steady wake effects are largest at zero advance ratio and low collective pitch. The effects remain significant at higher advance ratios and collective pitch settings. G.R.

A73-19192 * # Conformal mapping for potential flow about airfoils with attached flap. V. J. Rossow (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Aircraft*, vol. 10, Jan. 1973, p. 60-62. 6 refs.

The conformal mapping sequence presented transforms the potential flow about a circle into that about an airfoil with an attached flap or spoiler. It is found that adequate versatility of the flap shape for a given airfoil can usually be obtained with the indicated functions, although other transformations would expand the variety of possible flap shapes. G.R.

A73-19193 # Aircraft wing-tip vortex modification. P. O. Jarvinen (Sanders Associates, Inc., Nashua, N.H.). *Journal of Aircraft*, vol. 10, Jan. 1973, p. 63, 64. 10 refs.

The results of a low speed experimental wind tunnel study of the modification of a wing tip vortex are discussed, taking into account a tip mounted, upstream facing jet. Smoke flow visualization photographs show substantial enlargement of the vortex with increases in the jet momentum coefficient. Vorticity meter data are shown in a graph as a function of the jet momentum coefficient. G.R.

A73-19197 The effect of the degree of turbulence on the aerodynamic characteristics of planar decelerating cascades (Einfluss des Turbulenzgrads auf die aerodynamischen Eigenschaften von ebenen Verzögerungsgittern). R. Kiock (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *Forschung im Ingenieurwesen*, vol. 39, no. 1, 1973, p. 17-28. 36 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

The efficiency of the blading of a turbomachine depends mainly on the flow in the boundary layer at the blades and the separation characteristics. The flow in the boundary layer is significantly affected by the turbulence of the flow to the cascade, particularly in the case of small Reynolds numbers. The calculation of the frictionless degree of turbulence on the basis of the velocity distribution behind the cascade is considered, taking into account the potential theory. The computed degree of turbulence is compared with measured data obtained for various stages of an axial-flow compressor. G.R.

A73-19205 Calculation of the potential flow about axisymmetrical fuselages, annular profiles, and propulsion system inlets (Berechnung der Potentialströmung um rotationssymmetrische Rumpfe, Ringprofile und Triebwerkseinläufe). W. Geissler (Aerodynamische Versuchsanstalt, Göttingen, West Germany). (*Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 4th, Baden-Baden, West Germany, Oct. 11-13, 1971.*) *Zeitschrift für Flugwissenschaften*, vol. 20, Dec. 1972, p. 457-462. 9 refs. In German.

The calculation of the potential flow about bodies of revolution (closed bodies, inlets, cowlings) is done by a method using surface distributions of sources, sinks and vortices. This method deals with the case of an arbitrary flow about the body. Besides of axisymmetric flows and flows at incidence to the body axis it is possible to take care of the flow field induced by another body (interference problem). A panel method is used for the numerical solution of the

problem. In the case of an axisymmetric body the surface elements are frustrums of cones of small axial length. For different types of bodies the results of this method are compared with measurements. (Author)

A73-19347 # The pre-flight handling of inertial navigation systems. K. R. Brown and W. H. McKinlay. (Ferranti, Ltd., Holinwood, Lancs., England). *Journal of Navigation*, vol. 26, Jan. 1973, p. 13-20.

The accuracy afforded by inertial navigation systems is strongly affected by correct handling of the unit prior to takeoff. Basic system requirements and some detailed engineering considerations that affect operations taking place in an inertial navigator during the initial or preflight alignment sequence are explained in an attempt at evaluating possibilities for more rapid alignment. Recent studies show that it is possible to align the system with the instruments at the temperature existing at switch-on and with the wheel at low speed. Rapid heating is then applied when the system is navigating, and the wheels are accelerated to full speed at this time. The procedure results in considerable time savings. T.M.

A73-19348 # The growth of aircraft movements by 1985. (International Air Transport Association, Technical Conference, 19th, Dublin, Ireland, Oct. 1972.) *Journal of Navigation*, vol. 26, Jan. 1973, p. 26-32.

Forecast of the 1985 volume of aircraft traffic between selected city pairs and at individual terminal areas in Europe, North America, South America, and the Far East. Details of the forecasting technique are explained, and the tabulated results are examined in relation to the magnitude of the traffic handling task which can be expected to face the airline industry by 1985. T.M.

A73-19349 # Air traffic control by programmed navigation. K. Ramsayer (Stuttgart, Universität, Stuttgart, West Germany). (International Air Transport Association, Technical Conference, 19th, Dublin, Ireland, Oct. 1972.) *Journal of Navigation*, vol. 26, Jan. 1973, p. 33-36.

Description of a general scheme for automatic control and navigation of commercial air traffic in the future. Each aircraft is to fly according to a prescribed flight plan elaborated by a central air traffic control station and transmitted by data link to an airborne computer which monitors the navigation of the aircraft. The flight plan specifies positions, altitudes, and time within prescribed tolerances, and the navigation itself is based on an integrated inertial-DME system. T.M.

A73-19350 # A precision position and time service for the air traffic of the future. L. F. Fehlner and T. A. McCarty (Johns Hopkins University, Baltimore, Md.). (International Air Transport Association, Technical Conference, 19th, Dublin, Ireland, Oct. 1972.) *Journal of Navigation*, vol. 26, Jan. 1973, p. 37-54. 26 refs.

Extended Loran-C coverage is proposed as the key element of a precision position and time reference system for terminal and area navigation in a future air traffic control network. Maps show locations of 1.6-MW transmitters providing ground-wave coverage of the continental U.S. (17 stations) and Europe (19 stations). A Loran-C receiver in the aircraft measures the horizontal coordinates, and a calibrated digital barometric altimeter measures the vertical coordinate in the common grid system. The airborne navigation computer can be tied by data link to a ground-based central air-traffic control computer that elaborates and updates the flight plans. Sky-wave coverage over the North Atlantic provides control in that area. It is argued that the system cannot be saturated by increasing air traffic volume, and the well developed Loran-C technology offers reliable precision at substantial savings. T.M.

A73-19351 How can we use area navigation in the terminal area. N. H. Hughes (Royal Aircraft Establishment, Farnborough, Hants., England). (International Air Transport Association, Technical Conference, 19th, Dublin, Ireland, Oct. 1972.) *Journal of Navigation*, vol. 26, Jan. 1973, p. 55-60.

It is argued that currently available area navigation systems are incompatible with present terminal ATC approach sequencing procedures. Benefits which may result from the integration of area navigation systems with terminal ATC systems do not necessarily include increased traffic density since runway capacity is restricted by trailing-vortex and runway occupancy-time constraints. Such integration is only possible if computer assistance to the approach controller is combined with a data link between the ATC computer and the aircraft navigation system. The use of vertical navigation is suggested as a valuable first step to combined area and terminal control. T.M.

A73-19352 # The capacity of a single-runway S.T.O.L./R.T.O.L. airport. V. W. Attwooll and C. P. Hayfield. (International Air Transport Association, Technical Conference, 19th, Dublin, Ireland, Oct. 1972.) *Journal of Navigation*, vol. 26, Jan. 1973, p. 61-74. 7 refs.

The arrival and departure operations of three different types (100, 180, and 400 seats) of hypothetical STOL aircraft at a single-runway airport are examined in order to delineate factors affecting the traffic handling capacity. It is assumed that the airport operates without interference from conventional takeoff and landing (CTOL) aircraft. It is shown that separation requirements produced by turbulent-wake effects could strongly reduce the handling capacity. Aircraft design solutions to the turbulent-wake problem are particularly urged for the heavier versions of STOL aircraft. T.M.

A73-19403 # Calculation of the reliability of electronic components in an 'aeronautics' environment shaped by the operational service routines of onboard equipment devices used by Air France (Calcul de la fiabilité de composants électroniques dans l'environnement 'aviation' à partir du suivi d'exploitation d'équipements de bords utilisés par la compagnie Air-France). D. Levy (CNET, Centre de Fiabilité, Bagneux, Hauts-de-Seine, France). In: National Congress on Reliability; Perros-Guirec, Côtes-du-Nord, France, September 20-22, 1972, Text of the Lectures.

Paris, Centre National d'Etudes des Télécommunications, 1972, p. 41-47. In French.

A73-19468 # Mathematical model of nonstationary linear aeroautoelasticity (Matematicheskaya model' nestatsionarnoi lineinoi aeroavtougosti). S. M. Belotserkovskii. *Akademiia Nauk SSSR, Doklady*, vol. 27, Nov. 21, 1972, p. 557-559. In Russian.

The behavior of an elastic flight body is analyzed that moves through a continuous medium. The study of its flight control involves the combined solution of problems of aerodynamics, automatic control, and elasticity theory. This problem complex is therefore termed aeroautoelasticity. The analysis uses a rigorous approach based on linear nonstationary theory. M.V.E.

A73-19554 How practical are lab-oriented solid film lubricants. B. K. Gabel (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Assessment of lubricant technology; Proceedings of the Annual Spring Lubrication Symposium, Boston, Mass., June 6-8, 1972. New York, American Society of Mechanical Engineers, 1972, p. 15-19. 7 refs.

Discussion of some of the problems associated with the use of

solid-film lubrication on aircraft components. Special attention is given to surface precleaning and roughening, lubricant-film application and curing, and susceptibility to contamination and corrosion. Aerosol applicability, extended shelf life, and the development of corrosion-preventive properties are also reviewed. M.V.E.

A73-19563 The influence of lubricants on turbine engine design. T. E. Russell and J. E. Methlie (General Electric Co., Cincinnati, Ohio). In: Assessment of lubricant technology; Proceedings of the Annual Spring Lubrication Symposium, Boston, Mass., June 6-8, 1972. New York, American Society of Mechanical Engineers, 1972, p.135-142. 6 refs.

This paper addresses the problem of predicting the influence of lubricants on advanced gas turbine engine design and stresses the system's concept. Presented are discussion and supporting analytical techniques to indicate the relative importance of several lubricant properties as they pertain to the operation of a gas turbine engine. The properties considered are bulk oil stability, hot spot stability, vapor pressure, autoignition temperature, pumpability, gear load capacity and bearing life. Potential deficiencies in current criteria as applied to possible future high temperature designs and areas for further research are also indicated. (Author)

A73-19575 # Minimum performance standards - Airborne distance measuring equipment /DME/ operating within the radio-frequency range of 960-1215 megahertz. Washington, D.C., Radio Technical Commission for Aeronautics (Document No. DO-151), 1972. 61 p. \$6.00.

A73-19578 # The steady and unsteady aerodynamic coefficients for the rolling motion of slender wings (Über die stationären und instationären aerodynamischen Beiwerte für die Rollbewegung schlanker Flügel). F. Schlottmann. Bochum, Ruhr-Universität, Abteilung für Maschinenbau und Konstruktiven Ingenieurbau, Dr.-Ing. Dissertation, 1972. 120 p. 86 refs. In German. Research supported by the Nordrhein-Westfalen Landesamt für Forschung.

A test installation was developed for determining the aerodynamic forces acting on airfoils in the case of steady and unsteady rolling motions in a low-speed wind tunnel. The principles of operation of the test installation are described together with the measurement instruments employed. The rolling moment produced by the motion was determined as a function of roll angular velocity, its temporal derivative, and the angle of attack. The experimental results are compared with theoretical values obtained on the basis of linear and nonlinear steady airfoil theory or with the aid of linear unsteady theory. The occurrence of nonlinear effects is observed.

G.R.

A73-19604 # Hydraulic systems of modern aircraft. II (Układy hydrauliczne współczesnych samolotów. II). J. Filip. *Technika Lotnicza i Astronautyczna*, vol. 27, Dec. 1972, p. 15-17, 34. In Polish.

Description of hydraulic drive and control systems used for landing-gear retraction and extension on the Piper Cherokee Arrow and for main-wheel braking on the F-111. Some new applications of hydraulic drive systems for engine cranking and starting operations are also discussed. T.M.

A73-19605 # Development trends in aircraft-engine compressor design methods. III (Kierunki rozwoju metod projektowania sprężarek silników lotniczych. III). W. Kordziński. *Technika Lotnicza i Astronautyczna*, vol. 27, Dec. 1972, p. 18, 25, 26. In

Polish.

Simplified methods (based on two-dimensional flow theory) for the design of vaneless and bladed diffusers in centrifugal compressors are critically evaluated. Emphasis is placed on the drawbacks of existing computational procedures, and it is noted that the lack of systematic research on centrifugal compressors results in a situation where final performance characteristics depend on the intuition and luck of the designer. T.M.

A73-19625 An investigation of the intensity of turbulence in the region of the inflow of a jet of secondary air into the firing tube of a gas turbine engine chamber. G. M. Gorbunov, A. V. Peshkov, I. L. Khristoforov, and M. V. Emmil'. (*Aviatsionnaya Tekhnika*, vol. 14, no. 4, 1971, p. 38-43.) *Fluid Mechanics - Soviet Research*, vol. 1, Sept.-Oct. 1972, p. 170-175. 7 refs. Translation.

The intensity of mixing processes resulting from the crosswind injection of a system of circular jets is governed by the jet parameters, the depth of jet penetration, and the turbulence induced by jet wakes. Hot-wire anemometers were used to measure turbulence intensity near the inlet of a single jet and behind several jets of secondary air injected into the flame tube of a gas turbine engine. Results show that the use of optimally spaced transverse jets with a given depth of penetration makes it possible to attain a high level of turbulence that ensures active mixing of air and fuel. T.M.

A73-19942 A description of two low cost turbo-compressors built for powered lift research. J. A. Conway and K. A. J. Lockwood (de Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada). (*Canadian Aeronautics and Space Institute, Annual General Meeting, Toronto, Canada, May 18, 19, 1972.*) *Canadian Aeronautics and Space Journal*, vol. 18, Dec. 1972, p. 319, 320, M-2 to M-4.

A73-19952 * # Second derivatives of the flutter velocity and the optimization of aircraft structures. C. S. Rudisill (Clemson University, Clemson, S.C.) and K. G. Bhatia (NASA, Langley Research Center, Hampton, Va.). *AIAA Journal*, vol. 10, Dec. 1972, p. 1569-1572. Grant No. NGR-41-001-027.

Equations for the second partial derivatives of the eigenvalues of the flutter equation along with the equations for finding the second partial derivatives of the flutter velocity of an aircraft structure with respect to the structural parameters are derived. These partial derivatives are used to develop expressions for the step size in a projected gradient search along a constant mass hyperplane. A projected gradient search along with a gradient mass and a gradient velocity search is used to minimize the mass of a box beam which supports a lifting surface. (Author)

A73-19954 # Flow in the wake of a cascade of oscillating airfoils. W. P. Jones and J. A. Moore (Texas A & M University, College Station, Tex.). *AIAA Journal*, vol. 10, Dec. 1972, p. 1600-1605. 11 refs. Grant No. DA-ARO(D)-31-124-71-G153.

A study has been made of the amplitude and phase of the vertical oscillations in the wake behind (1) a cascade of airfoils oscillating in phase and (2) a cascade of airfoils at zero incidence with oscillating flaps. It was found that in both cases the amplitude of the flow oscillations in the wake remained approximately constant downstream for the values of frequency parameter and airfoil spacing considered. From the results of some preliminary experimental work it appears that sinusoidal gusts could be reproduced in an open jet wind tunnel with either system, but the second type of airfoil-flap arrangement is preferable in practice. The difficulties resulting from flow separation and early stalling which arise with the first system do not appear until much higher angular amplitudes are used when only the flaps are oscillated. (Author)

A73-19955 # Boundary-layer separation on rotating blades in forward flight. W. H. Young, Jr. and J. C. Williams (North Carolina State University, Raleigh, N.C.). *AIAA Journal*, vol. 10, Dec. 1972, p. 1613-1619. 16 refs. Grant No. DAAJ02-69-C-0086.

A study has been made to determine the effects of rotation, forward flight, angle of attack, lift, and downflow on the laminar boundary-layer separation on an idealized rigid blade of infinite extent. As a result of the method of analysis it is possible to isolate the effects of angle of attack, forward flight, and downflow velocity. In general, separation is delayed on the inboard portion of the blade as a result of rotation. This effect has been noted previously. For forward flight without downflow the separation point, at a given spanwise location, oscillates about the no-forward-flight separation point. In addition, the location of the separation point in this case is 90 deg out of phase with the velocity at the edge of the boundary layer. When both forward flight and downflow are included in the solution, the oscillations of the separation line are amplified and the separation line undergoes an additional phase shift in azimuthal angle. The larger the angle of attack, the more exaggerated are the amplifications of the oscillation in the separation line. (Author)

A73-19956 * # Multiple element airfoils optimized for maximum lift coefficient. A. I. Ormsbee (Illinois, University, Urbana, Ill.) and A. W. Chen (Illinois, University, Urbana, Ill.; NASA, Langley Research Center, Hampton, Va.). *AIAA Journal*, vol. 10, Dec. 1972, p. 1620-1624. Grant No. NGR-14-005-144.

Optimum airfoils in the sense of maximum lift coefficient are obtained for incompressible fluid flow at large Reynolds number. The maximum lift coefficient is achieved by requiring that the turbulent skin friction be zero in the pressure rise region on the airfoil upper surface. Under this constraint, the pressure distribution is optimized. The optimum pressure distribution is a function of Reynolds number and the trailing edge velocity. Geometries of those airfoils which will generate these optimum pressure distributions are obtained using a direct-iterative method which is developed in this study. This method can be used to design airfoils consisting of any number of elements. Numerical examples of one- and two-element airfoils are given. The maximum lift coefficients obtained range from 2 to 2.5. (Author)

A73-19964 # A correction to 'lifting-line theory as a singular perturbation problem.' K. P. Kerney (U.S. Naval Material Command, Ship Research and Development Center, Bethesda, Md.). *AIAA Journal*, vol. 10, Dec. 1972, p. 1683, 1684. 6 refs. Navy-supported research. Navy Task J-15090.

The formula given by Van Dyke (1964) for the lift-curve slope of a high-aspect-ratio elliptical wing in incompressible inviscid uniform flow is investigated with respect to its accuracy and proved to be incorrect. A corrected version of the formula is presented.

M.V.E.

A73-20014 # Vapor pressure of supersonic aircraft fuels (O davlennii parov topliva dlia sverkhzvukovykh samoletov). Ia. B. Chertkov and P. M. Kolobova. *Khimiia i Tekhnologiia Topliva i Masel*, vol. 18, no. 1, 1973, p. 46, 47. 7 refs. In Russian.

Vapor pressures and distillation fractions suitable for supersonic airliner fuels are discussed. A nomogram is proposed for the determination of boiling point vs temperature and absolute pressure in such fuels. A boiling point of 165 to 168 C for speeds of up to 2.5 M, and distillation fraction contents corresponding to Soviet T-8 fuel and western grade A fuel are suggested for supersonic airliners. V.Z.

A73-20077 # Flight control with incomplete information (Upravlenie poletom pri nepolnoi informatsii). G. I. Kostychev. *Aviatsionnaia Tekhnika*, vol. 15, no. 3, 1972, p. 12-15. In Russian.

A flight control algorithm is proposed for situations where the equations of motion contain a random quantity whose dispersion decreases with time due to incoming information, as under conditions of limited visibility. The algorithm yields a solution for an infinitesimal time interval in contrast to ordinary solutions in problems without information inflow, which provide controls averaged over the entire time of controlled operation. V.Z.

A73-20086 # Investigation of the heat transfer between the gas and casing in the area of the apertures between the nozzle diaphragm blades and guide vanes of turbines (Issledovanie teplootdachi mezhdru gazom i korpusom v raione mezhlopatochnykh kanalov soplovykh i napravliaiushchikh apparatov turbin). V. I. Lokai, M. N. Bodunov, V. A. Podgornov, and A. G. Karimova. *Aviatsionnaia Tekhnika*, vol. 15, no. 3, 1972, p. 62-67. 8 refs. In Russian.

A73-20094 # Calculation of the aerodynamic characteristics of a rectangular wing with tip plates moving at a low subsonic speed in the proximity of a screen (Raschet aerodinamicheskikh kharakteristik priamougol'nogo kryla s kontsevyimi shaybami, dvizhushchegosia s maloi dozvukovoi skorost'iu vblizi ekrana). S. D. Ermolenko, Iu. A. Rogozin, and G. V. Rogachev. *Aviatsionnaia Tekhnika*, vol. 15, no. 3, 1972, p. 105-112. In Russian.

A73-20095 # Accelerations of points on a flight vehicle during short-period motion (Uskorenniia tochek letatel'nogo apparata v korotkoperiodicheskom dvizhenii). B. D. Shneider. *Aviatsionnaia Tekhnika*, vol. 15, no. 3, 1972, p. 113-117. In Russian.

Demonstration that a point situated at some distance in front of the center of mass of a flight vehicle has minimum vertical accelerations during flight vehicle pitching. Considerations are given for determining the position of that point by measurements during flight. It is recommended that acceleration sensors of automatic pilots be positioned at that point. V.Z.

A73-20124 Advances in the design of electric three-phase machines for air and land vehicles (Fortschritte im Bau elektrischer Drehstrommaschinen für Luft- und Landfahrzeuge). P.-G. Sperling (Siemens AG, Nuremberg, West Germany). *Siemens-Zeitschrift*, vol. 46, Aug. 1972, p. 686-692. 6 refs. In German.

Developments in the technology, design, and cooling of three-phase machines are described which have led to new solutions in the construction of reliable efficient generators and motors for aircraft and land vehicles. The impact of semiconductor technology on the design of brushless generators is noted. One of the principal advances in aircraft generator design is the substantial reduction in the power-to-weight ratio. V.P.

A73-20157 Predicting light flashes due to alpha-particle flux on SST planes. P. S. Young (Mississippi State University, State College, Miss.) and K. Fukui (USAF; Cambridge Research Laboratories, Bedford, Mass.). *Nature*, vol. 241, Jan. 12, 1973, p. 112, 113. 11 refs.

Experiments conducted to determine the causes of the phenomenon experienced by the astronauts during the Apollo Lunar Missions confirm that the flashes were caused either by direct interaction between energetic heavy primary cosmic rays or neutrons and the retina, or by Cerenkov radiation produced by muons. Because the alpha-particle flux is much higher than that of heavy

nuclei in primary cosmic rays, the possibility of observing light flashes on SST aircraft owing to alpha-particles cannot be ruled out.
G.R.

A73-20171 A flight control system for STOL aircraft. G. Schänzer (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Interavia*, vol. 28, Jan. 1973, p. 66-68.

In order to avoid obstacles and to keep noise to a minimum, steep nonlinear approach profiles will be necessary in many cases when operating STOL aircraft. The deterioration of flight characteristics can be overcome by means of a suitable control system. For exact control of flight path and aerodynamic flow, altitude deviations and angle of attack deviations should be kept as low as possible. At least two independent control possibilities are necessary to control flight path and angle of attack independently. Spoilers are necessary for very precise landings.
F.R.L.

A73-20200 # On a particular case of conformal representation of multiconnected domains. W. J. Prosnak (Warszawa, Politechnika, Warsaw, Poland). *Académie Polonaise des Sciences, Bulletin, Série des Sciences Techniques*, vol. 20, no. 11, 1972, p. 11 (917)-17 (923). 5 refs. Research supported by the Zaklady Sprzetu Lotnictwa Sportowego.

Conformal representation of two profiles symmetric with respect to the real axis onto two such circles is considered in the paper. The mapping function is assumed in the form of a series of rational functions, and relations between coefficients of this series and coordinates of the profiles are established.
(Author)

A73-20214 A computerized flutter solution procedure. Y. T. Phoa (Technology, Inc., Dayton, Ohio). (*National Symposium on Computerized Structural Analysis and Design, George Washington University, Washington, D.C., Mar. 27-29, 1972.*) *Computers and Structures*, vol. 3, Jan. 1973, p. 195-204.

An approach has been developed to solve flutter equations completely automatically. The method consists of a computerized search for the flight speed, vibration frequency, and air density values which satisfy all conditions imposed by the flutter problem. Control theory concepts are used for the presentation and the aeroelastic system involved can be extended to include any type of linear feedback control device.
(Author)

A73-20244 Icing testing in the large Modane wind-tunnel on full-scale and reduced scale models (Essais de givrage dans la grande soufflerie de Modane sur maquettes à échelle grandeur et échelle réduite). F. Charpin and G. Fasso (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*Conférence sur la Protection Contre le Givrage, London, England, May 10, 1972.*) *L'Aéronautique et l'Astronautique*, no. 38, 1972, p. 23-31. 10 refs. In French.

A73-20246 Fatigue life of aircraft structures (Durée en fatigue des structures des avions). W. Barrois (Centre de Documentation de l'Armement, Paris; Société Nationale Industrielle Aérospatiale, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*NATO, AGARD, Symposium on Random Load Fatigue, Lyngby, Denmark, Apr. 13, 1972.*) *L'Aéronautique et l'Astronautique*, no. 38, 1972, p. 46-63. 26 refs. In French.

A brief review of the current methods for forecasting the fatigue life of aircraft structures according to the fatigue test results obtained on parts, assemblies, and structures under constant amplitude loads is presented. Following a discussion on the utilization

of the test results obtained under programmed loadings, the possibilities of using the tests under random loads in the range of slow fatigue are then studied. As a conclusion, it appears that the definition of a random loading by its root mean square value is not adequate to the forecasting of the lifetime of a structure subjected to fatigue even when the loading power spectrum pattern is known, barring the case of comparative forecasting where the sole variable is the intensity of a loading spectrum. The possibility of speeding up the test runs by a general increase of the load level has been contemplated.
(Author)

A73-20248 Basic specification research for the main instruments of light aircraft (Recherche de spécifications de base pour les instruments principaux destinés aux avions légers). R. Tiercelin. *L'Aéronautique et l'Astronautique*, no. 38, 1972, p. 73-80. In French.

A73-20249 India's wind tunnels (Die Windkanäle Indiens). A. Klein. *DGLR Mitteilungen*, vol. 6, Jan. 1973, p. 2-5. 11 refs. In German.

Review of the wind tunnel test facilities currently operating in India. After briefly outlining the current state of the Indian aircraft industry, descriptions are given of the low-velocity wind tunnels of the Indian Institute of Science, Hindustan Aeronautics Limited, and the Indian Institute of Technology, the high-velocity wind tunnel at the Indian Institute of Science, and two high-velocity wind tunnels at the National Aeronautical Laboratory, one of which, the large 120 x 120 cm wind tunnel is described in particular detail.
A.B.K.

A73-20350 Earlier programs spawned TF34. M. L. Yaffee. *Aviation Week and Space Technology*, vol. 98, Feb. 5, 1973, p. 56-60.

The TF34-GE-2 turbofan engine being produced for the Navy/Lockheed S-3A anti-submarine warfare aircraft is described, together with the TF34-GE-100 turbofan engine being developed for the USAF's close support AX aircraft built by Boeing. The principal components and characteristic features of these engines are examined. Both engines are designed on the basis of the technology developed for the TF39/CF6 and T64 engines.
V.P.

A73-20359 Emissions from and within an Allison J-33 combustor. A. M. Mellor, R. D. Anderson, R. A. Altenkirch, and J. H. Tuttle (Purdue University, Lafayette, Ind.). *Combustion Science and Technology*, vol. 6, Nov. 1972, p. 169-176. 11 refs. U.S. Environmental Protection Agency Contract No. 68-04-0001; Grant No. DAAE07-69-C-0756.

Gas temperature, carbon monoxide, and nitric oxide concentration profiles measured as a function of axial and radial position inside an Allison J-33 combustor with unheated inlet air are reported. In addition, the isolated effects of combustor pressure, overall equivalence ratio, and air flow rate on combustor exit plane emissions are investigated. A consistent model of the combustion process in this combustor is presented on the basis of the results.
(Author)

A73-20375 Air-terminal queues under time-dependent conditions. B. O. Koopman (Arthur D. Little, Inc., Cambridge, Mass.). *Operations Research*, vol. 20, Nov.-Dec. 1972, p. 1089-1114. 20 refs.

The queues formed by aircraft in stacks awaiting landing clearance have usually been treated either by machine simulation, or

analytically as stochastic processes with time-independent transition probabilities (possessing stationary solutions). In contrast to such methods, the present paper regards the queue-developing process in question as strongly time-dependent, often with a diurnal (24-hour) periodicity. The formulation and treatment are entirely analytic and make use of machines only to solve the equations for the probabilities, by economical deterministic steps, using the coefficients as given in tabular form. Time-varying Poisson arrivals are assumed, and also an upper limit to queue length. Two laws of servicing are used: Poisson and fixed service time; these extremes are found to lead to numerically close results in the realistic case.

(Author)

A73-20376 # Methods and equipment for in-flight aircraft strength tests (Metody i tekhnika letnykh ispytaniy samoletov na prochnost'). A. I. Gudkov and P. S. Leshakov. Moscow, Izdatel'stvo Mashinostroenie, 1972. 248 p. 39 refs. In Russian.

In-flight test methods for estimating the strength of aircraft and helicopters are presented. The main types of modern equipment for measuring vibrations, stress, temperature, and other parameters are described, and recommendations are made concerning the preparation and calibration of the equipment. Brief information is presented concerning laboratory strength tests of aircraft structures. Methods of in-flight strength testing involving load and vibration measurements are considered. Methods of analyzing measurement data on the basis of the special features of aircraft loading are outlined. The main types of automatic devices used for treating and analyzing measurement results are described.

A.B.K.

A73-20377 # Problems of passenger aircraft design (Problemy proektirovaniia passazhirskikh samoletov). V. M. Sheinin and V. I. Kozlovskii. Moscow, Izdatel'stvo Mashinostroenie, 1972. 312 p. 128 refs. In Russian.

A number of problems of passenger aircraft design are considered which are of interest from the standpoint of increasing the technical and economic efficiency of the aircraft and of the transport system as a whole. The trends of development of jet-powered passenger aircraft which tend to increase their profitability are noted, a detailed analysis is made of the concept of the airbus, problems of weight and size of a passenger aircraft are considered, the special features of designing aircraft with aft-mounted engines are indicated, and problems of optimal design are discussed. Also considered are some unsolved problems concerning takeoff and landing, flight range, and reliability.

A.B.K.

A73-20378 # Onboard distance-measuring systems (Bortovye distantsionno-izmeritel'nye sistemy). Iu. M. Pul'er. Moscow, Izdatel'stvo Mashinostroenie, 1972. 288 p. 47 refs. In Russian.

A study is made of onboard continuously operating and pulsed distance-measuring devices and measuring modulators. A general mathematical method is given for engineering calculation and error analysis of distance-measuring systems and individual measuring elements. The noise fluctuations of a servo microdrive and the effect of residual stress on its resolution are considered. The general principles of design of electromechanical measuring modulators - including those based on standard induction and logic electronic elements - are outlined. Calculations of specific measuring systems which have been used in flight vehicles are presented.

A.B.K.

A73-20381 # Control of aircraft and helicopter flight (Upravlenie poletom samoletov i vertoletov). V. T. Borodin and G. I. Ryl'skii. Moscow, Izdatel'stvo Mashinostroenie, 1972. 240 p. 136 refs. In Russian.

Analysis and systematization of the main results of non-Soviet research on the creation of promising means of automating aircraft and helicopter flight control. Structural diagrams and descriptions of control systems are presented for modern aircraft and helicopters, nonrigid flight vehicles, and adaptive (self-adjusting, variable-structure, and self-organizing) aircraft systems. Bionic principles of adaptation and the possibility of using them in flight vehicle control systems are considered, as well as problems involved in the automation of landings, flights at low and maximally low altitudes, and the creation of onboard equipment complexes. Methods of displaying piloting and navigational information to the pilot are described, as well as semiautomatic control systems, collision warning systems, landing systems, profile flight systems, and modern onboard equipment complexes.

A.B.K.

A73-20382 # System analysis of the air-ground transportation interface problem at Bangkok International Airport. C.-R. Wang. Bangkok, Asian Institute of Technology, Master of Engineering Thesis, 1971. 120 p. 15 refs.

The characteristics of passenger flows throughout the various facilities of the passenger and baggage handling system of the airport are studied. Because of the time-dependent nature of the demand for service, deterministic queueing models are considered to be appropriate for describing the passenger and baggage handling operations. From these results, applications are made to determine the effect of jumbo jet flights on the level of service in the future. The study includes the departure check-in counter, immigration and public health, the departure lounge, the arrival lounge, immigration check-in, and the baggage claim and customs inspection area.

F.R.L.

A73-20394 # Cost and economic factors in aerospace system development. A. H. Flax (Institute for Defense Analysis, Washington, D.C.). In: Management in science and technology. Porz-Wahn, Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, 1971, p. 176-209. 13 refs.

The cost of high-performance military and major transport aircraft has been growing exponentially over the past fifty years at about the rate of a tenfold increase every eighteen years. This increase in unit cost has been accompanied in recent years by an even sharper rate of increase in the cost of development. It will be increasingly necessary to recognize that the costs of development and production of aerospace systems are strongly dependent on the rate at which new technology is introduced.

G.R.

A73-20407 Superconducting a.c. machines - An approach to development. D. F. Warne and M. E. Hadlow (Electrical Research Association, Leatherhead, Surrey, England). In: International Cryogenic Engineering Conference, 4th, Eindhoven, Netherlands, May 24-26, 1972, Proceedings. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1972, p. 239-242.

The findings are reviewed of a study concerned with the evolution and evaluation of alternative configurations of superconducting ac machines, the comparison, in terms of weight, cost, and volume, with conventional machines at various points in the power spectrum, and an appraisal of the justification for development expenditure in the commercial (or market potential) context. It is shown that planar air gap machines are attractive (particularly in terms of specific volume) for medium power machines (about 20 MW), while cylindrical air gap machines show potential advantages across the full power spectrum.

V.P.

A73-20408 Superconducting generators for aircraft. J. T. Hayden (Cranfield Institute of Technology, Cranfield, Beds., England). In: International Cryogenic Engineering Conference, 4th, Eindhoven, Netherlands, May 24-26, 1972, Proceedings.

Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1972, p. 253-255. 6 refs.

The specific weights and performance characteristics of 400-Hz alternators employing superconducting field windings are calculated, and the general features of such alternators are discussed. It is shown that the main advantage which accrues from the use of superconducting field windings is the possibility of using high flux densities without the necessity of a heavy iron core. Some problems which must be resolved to obtain superconducting alternators suitable for use in aircraft are examined. V.P.

A73-20451 # Moving radiography. D. A. W. Pullen (Atomic Energy Research Establishment, Harwell, Berks., England). *Non-Destructive Testing Society of Great Britain, Annual Conference and Exhibition on Non-Destructive Testing, 9th, Loughborough University of Technology, Loughborough, Leics., England, Sept. 12-15, 1972, Paper. 13 p. 5 refs.*

The application of radiographic techniques to investigate dynamic events is becoming more widely used as engineers and others become increasingly aware of the unique facility it offers in recording for analysis details of motion which cannot be seen or photographed in the normal way. The motion may be transient or cyclic in nature, and the type of equipment necessary to obtain satisfactory radiographs varies from subject to subject. This paper reviews current methods of moving radiography with particular reference to the radiography of aero gas turbines under dynamic conditions, a development with which the author is closely involved. (Author)

A73-20452 # The corrosion problem in aircraft structures. P. F. Jowitt. *Non-Destructive Testing Society of Great Britain, Annual Conference and Exhibition on Non-Destructive Testing, 9th, Loughborough University of Technology, Loughborough, Leics., England, Sept. 12-15, 1972, Paper. 5 p.*

A historical overview of the aircraft corrosion problem and an assessment of the aircraft corrosion behavior of today. The subjects considered include corrosion in pressurized aircraft due to condensation, duralumin-related corrosion incidents, fatigue failures, magnesium-related corrosion failures, electrolytic corrosion, and anticorrosion plating. Nonexistence of corrosion on aircraft is urged as a necessity for safe flying. V.Z.

A73-20458 * Acoustic results obtained with upper-surface-blowing lift-augmentation systems. U. von Glahn, M. Reshotko, and R. Dorsch (NASA, Lewis Research Center, Cleveland, Ohio). *Acoustical Society of America, Meeting, 84th, Miami Beach, Fla., Nov. 28-Dec. 1, 1972, Paper. 25 p. 16 refs.*

The noise caused by the interaction of the jet exhaust and a wing was measured under static conditions for several versions of a small-scale STOL engine-over-the-wing configuration. Three basic nozzles were used in the tests; a circular nozzle, a 5:1 aspect ratio slot nozzle, and a 10:1 aspect ratio slot nozzle. Various flow attachment devices were included in the study. The wing included a flap that could be positioned for nominal takeoff or approach flap settings. Far field noise data are presented for the flyover mode. The data are discussed in terms of sound power and sound pressure spectra. (Author)

A73-20487 # Aerodynamic characteristics of thin asymmetric wing profiles in supersonic flow (Aerodynamische

Profileigenschaften der unsymmetrischen dünnen Flügel in der Überschallströmung). Y. Morikawa (Osaka University, Osaka, Japan), K. Nakabe (Osaka University, Osaka; Japan Monopoly Corp., Japan), S. Tada (Osaka University, Osaka; Hakodate Technical High School, Hakodate, Japan), and K. Nakamura (Osaka University, Osaka; Izumi Technical High School, Izumi, Japan). *Osaka University, Technology Reports*, vol. 22, Oct. 1972, p. 687-710. In German.

Expressions are derived for the lift, drag, and rolling-moment coefficients of a wing profile asymmetric with respect to the wing cord in three-dimensional flow. The influence of the profile configuration on the supersonic aerodynamic characteristics is studied by Busemann's approximate method as a function of the aspect ratio. V.P.

A73-20502 # A possible approach to the probabilistic estimation of the vibration strength of turbomachine components (Ob odnom vozmozhnom podkhode k veroiatnostnoi otsenke vibratsionnoi prochnosti detalei turbomashin). B. F. Shorr, E. A. Lokshtanov, and Iu. M. Khalatov (Tsentr'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR). *Problemy Prochnosti*, vol. 4, Nov. 1972, p. 11-14. 7 refs. In Russian.

A method of assessing the vibration strength of turbine components on the basis of a safety factor calculated from the statistically maximal values of the variable acting and breaking stresses is proposed. The statistically maximum stresses are determined with allowance for certain random factors which influence the nature of the stress distribution near a dissipation center. The advantage of using statistically maximum stresses instead of maximal measured stresses is demonstrated. V.P.

A73-20503 # Designing turbomachine blades for forced vibrations under various excitation conditions (Raschet lopatok turbomashin na vynuzhdennye kolebaniia pri razlichnykh tipakh vozbuzhdeniia). Iu. S. Vorob'ev and N. G. Medvedev (Akademiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR). *Problemy Prochnosti*, vol. 4, Nov. 1972, p. 15-19. 6 refs. In Russian.

The problem of the forced vibrations of rotor blades is solved by a variational method on the basis of an improved vibration theory for twisted rods which takes into account the influence of aerodynamic damping and inelastic internal resistance. The vibration modes and the distribution of internal forces, moments, and stresses along the blades are determined for loads varying arbitrarily in time over the blade length. V.P.

A73-20546 # System for in-flight recording of the rotational speed of the turbine of a jet engine (Uklad do rejestracji obrotow turbiny silnika odrzutowego w czasie lotu samolotu). R. Kudelski (Wojska Lotnicze, Instytut Techniczny, Warsaw, Poland). In: Measurement of dynamic mechanical quantities; Scientific-Engineering Conference, 3rd, Warsaw, Poland, October 26-28, 1972, Summaries. Warsaw, Instytut Lotnictwa, 1972, p. 244-246.

In Polish.

A73-20586 Recent advances and applications in the prediction of pilot acceptance of aircraft flying qualities. J. R. Stone and F. R. Naylor (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Conference on Decision and Control and Symposium on Adaptive Processes, 11th, New Orleans, La., December 13-15, 1972, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 262-265. 16 refs.

A recently developed digital computer program capable of predicting pilot-vehicle performance, pilot model parameters, and pilot acceptance (in terms of Cooper ratings) is used to study the longitudinal flying qualities of a large aircraft. The predictions are then compared with actual in-flight simulation data and with

fixed-base pilot describing function measurements. The complete package represents the largest and most recent set of data available for the pitch axis control task. The results are very promising and clearly demonstrate the utility of modern optimization techniques and identification methods. (Author)

A73-20588 * Nonlinear programming in design of control systems with specified handling qualities. A. A. Schy (NASA, Langley Research Center, Hampton, Va.). In: Conference on Decision and Control and Symposium on Adaptive Processes, 11th, New Orleans, La., December 13-15, 1972, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 272-279.

A method is described for using nonlinear programming in the computer-aided design of aircraft control systems. It is assumed that the quality of such systems depends on many criteria. These criteria are included in the constraints vector, and the design proceeds through a sequence of nonlinear programming solutions in which the designer varies the specification of sets of requirements levels. The method is applied to design of a lateral stability augmentation system (SAS) for a fighter aircraft, in which the requirements vector is chosen from the official handling-qualities specifications. Results are shown for several simple SAS configurations designed to obtain desirable handling qualities over all design flight conditions with minimum feedback gains. (Author)

A73-20600 Distributed control of air traffic. W. M. Hollister and R. W. Simpson (MIT, Cambridge, Mass.). In: Conference on Decision and Control and Symposium on Adaptive Processes, 11th, New Orleans, La., December 13-15, 1972, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 576-581. 10 refs.

Performance measures for the evaluation of advanced Air Traffic Control concepts are developed and applied to a number of proposed systems. Distributed control has the potential for reducing cost, increasing capacity and reducing risk relative to centralized systems. The concept requires that traffic information be available in the cockpit. (Author)

A73-20618 # Mass air travel is definitely possible (Visst ar folkflyget mojligt). O. Ljungstrom (Styrelsen for Teknisk Utveckling, Stockholm, Sweden). *Teknisk Tidskrift*, vol. 103, Jan. 19, 1973, p. 15-19. In Swedish.

Outline of proposed air traffic developments to make possible a mass ridership in Sweden. The existing situation with respect to air travel in Sweden is reviewed, and criticism is made of the poor scheduling, unduly long travel times, and high fares which have resulted in a smaller percentage of the public traveling by air in Sweden than in Norway and Denmark. A scheme is then proposed to increase the air ridership in Sweden through the immediate introduction of jet aircraft on lines which are still using propeller-driven aircraft and the eventual introduction of the so-called QSTOLs or QTOLs around 1980. In addition, a new fare structure is proposed which would make fares for longer distances lower than at present while simultaneously increasing fares for short distances. A.B.K.

A73-20677 Computer-controlled software diagnosis of an airborne computer. E. D. Smally (MIT, Cambridge, Mass.). In: Automatic support systems for advanced maintainability; Symposium, Philadelphia, Pa., November 13-15, 1972, Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 17-21. 10 refs. Navy-supported research.

The effort required and the important concepts involved in developing a single software diagnostic package for an airborne guidance computer are described in this paper. The paper is an attempt by the author to share some of the knowledge gained in planning, developing, and in using the diagnostics. The diagnostic

philosophy, diagnostic methods, test generation methods, and test validation methods used to develop the diagnostics are briefly described. (Author)

A73-20679 Some UK military views on the development and procurement of AIDS, BIT and ATE for avionics. M. H. Walshaw (Royal Aircraft Establishment, Farnborough, Hants., England). In: Automatic support systems for advanced maintainability; Symposium, Philadelphia, Pa., November 13-15, 1972, Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 50-56.

The paper first deals with the applications of AIDS and BIT, and comments on several specific aspects, including integrated avionics and flight control systems, before putting forward an overall view on the philosophy of on-aircraft monitoring and maintenance testing. The use of ATE for off-aircraft avionics testing is considered, and computerised ATE and software are discussed. The latter discussion covers the use of standard high-level languages, such as ATLAS, for test-specification writing and the relative merits of some compiling schemes. One such scheme could employ a new intermediate-level language called IDA, which has been designed to ease the problems which arise in compiling. (Author)

A73-20680 AUTOMATE - A self-contained automatic test system. T. L. Rothwell (Hughes Aircraft Co., Culver City, Calif.). In: Automatic support systems for advanced maintainability; Symposium, Philadelphia, Pa., November 13-15, 1972, Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 61-70.

AUTOMATE is a remarkably flexible and cost-effective computer-controlled automatic test system, developed by Hughes for use in its manufacturing plants. It is self-contained and designed to handle different products with widely different production rates. ATLAS is used for both analog and digital testing. Key system features include the use of a central computer/satellite test station concept, an ATLAS compiler resident on the central computer which is accessible in real-time from the test station for on-line ATLAS program development, and the maximum use of low-cost, low-risk commercial equipment. The result is a user-oriented system easily applied by test engineers and technicians and operable by lower skilled personnel. The AUTOMATE system, its software, and some of the user experience are described. Extensions of the design to other applications are covered briefly. (Author)

A73-20683 Test techniques for advanced avionics displays. J. W. Kenney (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). In: Automatic support systems for advanced maintainability; Symposium, Philadelphia, Pa., November 13-15, 1972, Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 89-94.

Some displays testing problems are examined, with emphasis on some unique techniques which are described in detail. Their flexibilities and shortcomings are discussed. Because many of the displays requiring functional and fault isolation testing were exceedingly complex, it was decided that automated (as opposed to manual) testing would be required. Video position measurements, manual visual testing with a programmable cursor, moving map display testing, complex video display testing, and automatic video testing with programmable video are considered. Attention is given to current limitations and future needs. F.R.L.

A73-20687 ATE support software system concept. C. H. Kozin and R. F. Huggard (PRD Electronics, Inc., Syosset, N.Y.). In: Automatic support systems for advanced maintainability; Symposium, Philadelphia, Pa., November 13-15, 1972, Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 141-151. 5 refs. Navy-supported research.

A73-20688

Description of a system concept for the definition and development of support software for automatic test equipment (ATE). The essential objective of an automatic test system is the capability for the user to generate a test program once and repeatedly use it thereafter for maintaining his equipment. The user's performance in the generation of a test program depends heavily on the ATE system support software. The basic support software to the test program developer is the translation system (i.e., language, translator, and operating system) which allows him to clearly express his test requirements. The features of the language, the translator, and the operating system as elements of a closed-loop ATE system are described, and the rationale for allocation of the ATE system requirements to a particular element of the support software is presented. (Author)

A73-20688 Extension of the VAST software system. D. J. Zingg (Lockheed-California Co., Burbank, Calif.). In: Automatic support systems for advanced maintainability; Symposium, Philadelphia, Pa., November 13-15, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 161-165.

One of the major problems encountered in the design and development of avionics test program sets for the versatile avionics shop test (VAST) system are with the VITAL compiler and lack of useful 'on-station' debug aids that are available to the user. While some of these problems are peculiar to the VAST software system itself, many are of a general nature and apply to program development on any automatic test system. This paper cites some of the major problems in the use of the compiler, how many of these problems are alleviated with an 'on-station' program patching capability, and the features of the compiler that should be carefully considered when designing any future ATE software systems. (Author)

A73-20692 Crew station lighting - Commercial aircraft. SAE Aerospace Recommended Practice, ARP 1161, May 1972. 25 p.

A practical set of requirements is given for lighting systems to illuminate crew station areas and displays on commercial aircraft and aerospace vehicles. The requirements pertain to display color; light control; instrument lighting systems; readability; lightplates; circuit breaker lighting; warning, caution and advisory systems lighting; and factors affecting human perception. V.Z.

A73-20693 Comparison of ground-runup and flyover noise levels. SAE Aerospace Information Report, AIR 1216, Apr. 1972. 28 p.

Sound pressure level measurements were made on 707-320C four-engine jet transport and 727-100 three-engine jet transport during concrete-surface runup, grassy surface runup, and overfly. The differences between composite one-third-octave-band spectra of noise were determined under these conditions. Comparisons were also made of the differences between maximum one-third-octave-band sound pressure levels measured during the ground runups over the concrete surface and over the grassy surface and projected to a 400 ft sideline distance. The projections included corrections for inverse-square loss and atmospheric absorption. Distinct differences were established in the results for the two aircraft. V.Z.

A73-20694 General requirements for aerospace powered mobile ground support equipment. SAE Aerospace Recommended Practice, ARP 1247, Apr. 1972. 18 p.

A73-20696 Gas turbine engine transient performance presentation for digital computer programs. SAE Aerospace Recommended Practice, ARP 1257, June 1972. 22 p. 5 refs.

A technique is set forth for the presentation of gas turbine engine transient performance as obtained by programmed digital computer calculations. The presentation is compatible with that given in issue 681 and is intended to assist program users as a readily computer-adaptable aid. V.Z.

A73-20698 Aircraft noise research needs. SAE Aerospace Information Report, AIR 1079, May 1972. 4 p.

The following research areas are identified as basic to aircraft noise control: noise from components of power sources; duct treatment materials and technologies for noise minimization in ducts and nacelles; noise propagation in the atmosphere and over the ground; and community and cabin noise. Continued improvement in these areas is suggested as a prerequisite for quiet operation of future commercial aircraft. V.Z.

A73-20718 # Unsteady thin-airfoil theory for subsonic flow. C. Osborne (Cornell University, Ithaca, N.Y.). AIAA Journal, vol. 11, Feb. 1973, p. 205-209. 13 refs. USAF-supported research.

An approximate theory has been developed for the unsteady motion of a two-dimensional thin airfoil in subsonic flow. Closed-form expressions are presented for the forces on, the circulation about, and the strength of the vortex wake emanating from a two-dimensional thin airfoil subjected to the general class of oscillating upwash distribution whose x dependence may be expanded in a cosine series. Expressions are also set down for three particularly important examples of this upwash distribution - namely, the Kemp-type upwash, the convected sinusoidal gust, and the flutter case. Some preliminary comparisons of the present method with the few existing theories for the sinusoidal-gust case reveals good agreement up to at least $M = 0.6$. (Author)

A73-20938 # Conically cambered triangular wings with reflex spanwise curvature. V. S. Holla, T. N. Krishnaswamy (Indian Institute of Science, Bangalore, India), and S. M. Ramachandra (Hindustan Aeronautics, Ltd., Bangalore, India). Aeronautical Society of India, Journal, vol. 24, Aug. 1972, p. 321-338. 16 refs.

A systematic study of conically cambered triangular wings with reflex spanwise curvature is made in this paper. The wings considered are those having subsonic leading edges and supersonic trailing edge with zero load along the leading edge at the design condition. It is shown through numerical examples that these wings have good aerodynamic characteristics, comparable to those of plane triangular wings with leading edge suction. (Author)

A73-20939 # Aerodynamic experimental investigation of annular cascade of gas turbine nozzle blade in subsonic and supersonic flow. K. L. Yadao (Government Engineering College, Jabalpur, Madhya Pradesh, India). Aeronautical Society of India, Journal, vol. 24, Aug. 1972, p. 339-343. 7 refs.

A73-20947 # Optimisation in construction of the Jaguar and other military aircraft. I. C. Taig and R. I. Kerr (British Aircraft Corp., Ltd., Military Aircraft Div., Preston, Lancs., England). Aircraft Engineering, vol. 45, Jan. 1973, p. 9-11. 6 refs.

A73-20958 # Expectation of contract incentives. J. A. Finchum, Jr. (Standard Oil Co., Chicago, Ill.). Naval Research Logistics Quarterly, vol. 19, June 1972, p. 389-397. 11 refs.

The application of statistical expectation to risk density

functions and fee/incentive-element relationships is shown to be useful in structuring contract incentives. A mathematical procedure for calculating the expected value of fee for a given risk/incentive arrangement is described along with cost examples and related sensitivity analyses. The structuring of equivalent incentives is demonstrated by the use of the contracting procedure used for procuring the C-5A aircraft. (Author)

A73-21000 # Benefit-cost analysis of delay reduction with STOL. J. B. Barriage (FAA, Aircraft and Noise Abatement Div., Washington, D.C.) and S. P. E. Price (U.S. Department of Transportation, Urban Mass Transportation Administration, Washington, D.C.). (*American Society of Civil Engineers, National Transportation Engineering Meeting, Seattle, Wash., July 26-30, 1971, Preprint 1507.*) ASCE, *Transportation Engineering Journal*, vol. 99, Feb. 1973, p. 43-52. 10 refs.

Various strategies for investment in STOL fleets have been evaluated with the aid of a heuristic computer model of the decision process which tallies incremental investment costs and incremental resulting benefits. The model is composed of about 700 FORTRAN statements and requires about one minute of running time on a CDC 6600 computer. The model was run with projected demand and capacity conditions for 1975. The outcome of STOL fleet and runway investments specified by the model is graphically portrayed as a series of city-pair STOL fleet costs (investments) and corresponding benefits (reduced costs of delay). T.M.

A73-21087 Applications of the infrared to navigation (*Applications de l'infrarouge à la navigation*). C. Lemonon (Thomson-CSF, Corbeville, Essonne, France). *Navigation* (Paris), vol. 21, Jan. 1973, p. 32-46. 7 refs. In French.

The infrared systems most appropriate as navigational aids are highly sensitive image formation radiometers. The essential characteristics of an image-forming radiometer are the image rate, the number of points resolved in the image, and the thermal sensitivity. These characteristics are closely related, and it is not possible to obtain simultaneously a high sensitivity at a rapid rate, and high resolution. The use of the radiometer for blind landing, for aerial reconnaissance over land and sea, for horizon detection, and for detection of obstacles at sea are discussed. Brief comment is made on the use of ultraviolet radiation for navigation. F.R.L.

A73-21088 Evolution and actual aspect of air navigation (*Evolution et aspect actuel de la navigation aérienne*). P. Fombonne (Thomson-CSF, Paris, France). *Navigation* (Paris), vol. 21, Jan. 1973, p. 63-75. In French.

The development of air navigation over the past twenty years is reviewed, with discussion of requirements and methods. A major factor has been the great increase in air traffic. A crucial event was the appearance of civil jet aircraft about 1960. The technical key to air navigation has been the progress of electronics during the period. Many innovations, such as the semiconductor revolution, have made it possible to construct apparatus which would have been impractical in 1953 on account of size and cost. Various navigational systems are described, and future possibilities are discussed. F.R.L.

A73-21180 Measurement of the pressure distribution at the surface of an aerodynamic body using a special interrogator. O. R. Cheranovskii and V. B. Zozulia (Khar'kovskii Aviatsionnyi Institut, Kharkov, Ukrainian SSR). (*Gidromekhanika*, no. 15, 1969, p. 65-69.) *Fluid Mechanics - Soviet Research*, vol. 1, Nov.-Dec. 1972, p. 51-54. Translation.

Description of a device proposed for measuring the pressure distribution over a profile by means of a pneumatically activated inductive sensor. By means of an interrogator switch, pressure measurements at 50 points of the profile can be obtained during 1 sec. V.P.

A73-21235 Welding and fabrication of non-ferrous metals; Proceedings of the International Conference, Eastbourne, Sussex, England, May 2, 3, 1972. Volume 1. Conference sponsored by the Welding Institute and Institute of Metals. Cambridge, Welding Institute, 1972. 132 p. Members, \$10.42; nonmembers, \$15.63.

Welding process parameters, participating reactions and mechanisms, weld properties, and inspection techniques are described in papers dealing with the fabrication and welding of aluminum, copper, zirconium, and other nonferrous alloys. Topics examined include hot crack formation during welding of aluminum and its alloys, problems in electron-beam welding of nonferrous metals, argon-nitrogen gas metal-arc welding of nonferrous metals, friction-welding experiments, cold-pressure welding of aluminum, explosive and implosive welding of duplex metal cylinders, welding of titanium alloy airframe structures with the aid of tensile loading to overcome distortion, and fatigue properties of welded high-temperature alloys. T.M.

A73-21240 Welding airframe structures in titanium alloys using tensile loading as a means of overcoming distortion. A. Stanhope, R. H. Hazelhurst, and B. M. Swann (Hawker Siddeley Aviation, Ltd., Kingston on Thames, England). In: *Welding and fabrication of non-ferrous metals; Proceedings of the International Conference, Eastbourne, Sussex, England, May 2, 3, 1972. Volume 1.* Cambridge, Welding Institute, 1972, p. 72-82.

The traditional method of stiffening aircraft wing or fuselage panels is by attaching longitudinal stiffeners or 'stringers' or alternatively machining integrally stiffened structure from the solid. There are obvious advantages in welding the stringers to the skin, and design studies have suggested that a U section would often be the most efficient structurally. Fusion welding such a joint invariably leads to considerable distortion. This distortion is caused by stresses locked into the welded zone as solidification proceeds. The present work shows how these normal residual stresses can be balanced out by the application of a relatively large tensile prestrain to the parts prior to welding. The panels produced by this method have been shown to be perfectly flat and distortion-free. The case for using titanium alloys as materials for aircraft construction is put forward, together with some problems associated with welding these materials. (Author)

A73-21249 A proposed design for the construction of a VTOL simulator (*Ricerca di progetto a realizzazione del simulatore per un velivolo a decollo verticale*). A. Folchini and M. Grande. *Rivista Aeronautica*, vol. 48, Dec. 1972, p. 2011-2028. In Italian.

Development of a design for a VTOL aircraft capable of fulfilling transport, training, and combat functions, giving particular attention to the construction of a simulator for predicting the effective behavior of this aircraft in flight. Among the design problems considered are the lift augmentation system, the architecture of the aircraft, the weight distribution, size limitations within the fuselage, flight safety, and aircraft stability and control. In connection with the simulator, a detailed description is given of the principle of operation and the circuitry employed. Also described is a proposed scheme for providing the pilot with the maximum information possible concerning the outside world using only a visual screen (an oscilloscope) and qualitative data concerning speed, attitude, and altitude. The results of preliminary tests carried out with the aid of the simulator are illustrated graphically. A.B.K.

A73-21495 Flow in the vicinity of a trailing edge (*Ecoulement au voisinage d'un bord de fuite*). J.-P. Guiraud (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine; Paris VI, Université, Service de Mécanique, Paris, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques*, vol. 276, no. 5, Jan. 29, 1973, p. 399-401. 5 refs. In French.

The triple layer method conceived by Stewartson and Williams (1969) and utilized in various applications by Stewartson (1969),

Brown and Stewartson (1970), and Riley and Stewartson (1969) is considered for further uses. It is applied to the study of the three-dimensional flow of an incompressible, viscous fluid in the vicinity of the trailing edge of a thin wing. The advantages and limitations of the method are pointed out. M.V.E.

A73-21529 ONERA will put a large anechoic chamber with a wind tunnel in service in 1975 (L'ONERA mettra en service in 1975 une grande chambre sourde avec soufflerie). J. Morisset. *Air et Cosmos*, vol. 10, Feb. 10, 1973, p. 23-25. In French.

The major feature of the anechoic chamber is an open aerodynamic circuit, or pseudo wind tunnel, consisting of an air inlet, a free jet test chamber, and an outlet with two fans driven by variable frequency electric motors. The pseudo wind tunnel will accomplish total soundproofing, will optimize the aerodynamics of the sound absorbing elements, and will achieve a very good flow without turbulence. The installation will make it possible to study jets with or without reheating, the blowers of turbojets at various rates of dilution, helicopter rotors, and models of V/STOL aircraft using jets for lift-off. F.R.L.

A73-21574 L-1011 TriStar - Design development. J. B. Beach (Lockheed-California Co., Burbank, Calif.). *Esso Air World*, vol. 25, no. 2, 1972, p. 36-41.

A distinct improvement in handling qualities for large transport aircraft was a major objective in the design of the L-1011. The 'flying stabilizer' augmented by elevators linked to the stabilizer motion was evolved so as to camber the stabilizer surface as a function of stabilizer deflection. Variations in center of gravity have a very small effect on the feel of the airplane. Avionics flight control and automatic landing systems, structure and corrosion protection, hydromechanical systems, and aspects of maintenance and noise abatement are discussed. F.R.L.

A73-21611 # Discrete vortex scheme of a wing of finite span (O diskretnoi vikhrevoi skheme kryla konechnogo razmakha). N. F. Vorob'ev (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriya Tekhnicheskikh Nauk*, Oct. 1972, p. 59-68. 5 refs. In Russian.

The flow of an inviscid incompressible gas past the lifting surface of a wing is analyzed. A vortex surface is substituted for the wing surface, and the trailing vortex sheet is represented by a vortex surface whose axes coincide with the stream lines. The introduction of the trailing vortex sheet helps to ensure the condition of a finite velocity at the trailing edges. The calculation of the aerodynamic characteristics of the wing is reduced to the solution of a system of algebraic equations. It is shown that, if the discrete vortices are properly selected and certain conditions are satisfied, the algebraic sums which represent the velocities induced by the discrete vortices, reduce with increasing number of the vortices to integrals. The convergence of the integrals is proved. V.P.

A73-21656 Contribution to the study of the total energy. III (Contribution à l'étude de l'énergie totale. III). J. M. Clément. *Aero-Revue*, Feb. 1973, p. 91-93. In French.

A rate of climb indicator for a glider is described. The perfect total energy developed in gliding flight passes by an accelerometric compensation. The application of a theoretical C sub p equals -1 leads to an unusable rate of climb indicator because it is apparently overcompensated at the beginning of the retrim and indicates delays of several seconds, which must be added to the delay of the instrument itself. It is possible to artificially compensate the accelerometric error by undercompensating the rate of climb indicator by a quantity diminishing with the speed. F.R.L.

A73-21670 Analytical predictions of emissions from and within an Allison J-33 combustor. D. C. Hammond, Jr. and A. M. Mellor (Purdue University, Lafayette, Ind.). *Combustion Science and Technology*, vol. 6, Jan. 1973, p. 279-286. 20 refs. Grant No. DAAE07-69-C-0756.

An analytical model which considers gas-phase processes has been developed for gas turbine combustors. In the model the fluid mechanics of combustors are rather crudely approximated for reasons of mathematical tractability, and the perfectly stirred reactor constitutes the basic computational component of the model. The analytical model was used to make predictions, for an actual combustor, which were then compared with internal and exit plane measurements of temperature, carbon monoxide concentration, and nitric oxide concentration. The internal data could be reasonably well approximated by the predictions, but the variations in exit plane values for certain changes in the operating conditions were incorrectly predicted. These discrepancies were shown to result, at least partially, from heterogeneous effects. (Author)

A73-21683 * # A summary of wind tunnel research on tilt-rotors from hover to cruise flight. Ph. Poisson-Quinton (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) and W. L. Cook (NASA, Ames Research Center Advanced Aircraft Programs Office, Moffett Field, Calif.). (NATO, AGARD, Réunion sur l'Aérodynamique des Voilures Tournantes, Marseille, France, Sept. 13-15, 1972.) *ONERA, TP* no. 1133, 1972. 18 p.

A73-21687 Olympus in Concorde /Twenty-fifth Louis Bleriot Lecture/. J. Devriese (Société Européenne de Propulsion, Paris, France) and P. H. Young (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). (*L'Aéronautique et l'Astronautique*, no. 37, 1972, p. 5-22.) *Aeronautical Journal*, vol. 76, Dec. 1972, p. 683-694. 6 refs.

It has been demonstrated during flight tests that the Olympus engine cycle, eight years after it was designed, is perfectly suited to supersonic operation. Engineering improvements such as: intake casing assembly, annular combustion chamber, modern means of soundness monitoring, etc., were introduced to maintain the engine in the lead of advanced technology while satisfying pollution requirements. Noise reduction is being subjected to extensive research, with continuous improvements being introduced. The use of reheat - with a ratio increased to 18 per cent - was extended to transonic flight operation. Increased payload is ensured by the new type of secondary nozzle, which also contributes to noise abatement. Further engine developments are being considered. (Author)

A73-21688 Advanced materials for aircraft brakes. J. V. Weaver (Dunlop, Ltd., Aviation Div., Foleshill, Coventry, England). *Aeronautical Journal*, vol. 76, Dec. 1972, p. 695-698.

Material requirements for aircraft brakes are explained, and the thermal and mechanical properties of some advanced materials are outlined to demonstrate applications in solving problems encountered with recent brake design developments. Friction and wear characteristics, density, oxidation resistance, and mechanical strength are discussed for beryllium, steel, electrographite, nuclear grade graphite, high-density mechanical carbon, pyrolytic graphite, and carbon-fiber/carbon-matrix materials. T.M.

A73-21689 Formula one air racing. R. J. Hardy (Southampton, University, Southampton, England). *Aeronautical Journal*, vol. 76, Dec. 1972, p. 699-703.

The history of formula-one air racing in the United States and Great Britain is reviewed in terms of major competitive events, successful aircraft designs, and important design requirements. Specifications are given for a racer aircraft (Hobbit) offering simple low-cost construction by amateurs along with good racing and touring characteristics. T.M.

A73-21692 A linearised theory of parachute opening dynamics. H. G. Heinrich (Minnesota, University, Minneapolis, Minn.). *Aeronautical Journal*, vol. 76, Dec. 1972, p. 723-731. 19 refs.

The present analysis of parachute inflation dynamics introduces a refined inflow function and corrects a conceptual error appearing in the analytical method for calculating parachute opening time and opening shock described by Heinrich and Bhateley (1961). Calculated values of opening time and force obtained by the present improved method are in good agreement with available field test data. Effects of drag coefficients, inflation altitude, and volume of the inflated canopy are indicated. T.M.

A73-21710 * The utility of a low flying aircraft or helicopter when collecting ground data for regional resource surveys. D. T. Lauer (California, University, Berkeley, Calif.). In: American Society of Photogrammetry and American Congress of Surveying and Mapping, Fall Convention, Columbus, Ohio, October 11-14, 1972, Proceedings. Falls Church, Va., American Society of Photogrammetry, 1972, p. 367-383. 6 refs. NASA-supported research. NASA Order R-03-038-002.

A73-21725 # Nonstationary load distribution on an arbitrary-planform wing in supersonic motion (Nestatsionarnye raspredelennye nagruzki na kryle, imeiushchem proizvol'noi formu v plane, pri sverkhzvukovom dvizhenii). R. A. Mezhlumian (GosNII Glavavtomatika, Moscow, USSR) and R. Sh. Solomonian (Akademiia Nauk Armianskoi SSR, Nauchno-Issledovatel'skii Institut Avtomatiki, Kirovakan, Armenian SSR). *Akademiia Nauk Armianskoi SSR, Izvestiia, Mekhanika*, vol. 25, no. 3, 1972, p. 41-59. 7 refs. In Russian.

A73-21837 Civil aviation development - A policy and operations analysis. R. C. Fraser, A. D. Donheiser, and T. G. Miller, Jr. (Arthur D. Little, Inc., Cambridge, Mass.). Research supported by the U.S. Department of Transportation; Contract No. DOT-OS-00083. New York, Praeger Publishers, Inc., 1972. 213 p. \$12.50.

Research findings are synthesized and enumerated, and the most comprehensive constraints and broad classes of options are discussed, followed by examination in greater detail of more specific constraints and options. The R & D problem is defined, and ways are indicated in which government and industry are not meeting the research challenge. The commercial airlines industry and its key interfaces with government are examined in order to evaluate the R & D implications of an historically close-knit private-public sector operation. The question of airport development is discussed. An examination of commercial helicopter operations, air cargo, STOL, and general aviation provides numerous examples of the difficulties facing civil aviation R & D. F.R.L.

A73-21839 Aircraft structures for engineering students. T. H. G. Megson. London, Edward Arnold (Publishers), Ltd., 1972. 493 p. 76 refs. \$15.63.

This unified course considers the fundamentals of elasticity and aircraft structural analysis, and the associated topics of airworthiness and aeroelasticity. Sufficient elasticity theory is included to provide the basic tools of structural analysis. An attempt is made to clarify the use of energy methods of analysis and to present a consistent but general approach to the various types of structural problems for which energy methods are employed. The analysis of the thin-walled cellular type of structure is extensively treated. An introduction to computational methods of structural analysis is presented which also includes some elementary work on the finite element method for continuum structures. F.R.L.

STAR ENTRIES

N73-15978 Engineering Sciences Data Unit, London (England).
**INFORMATION ON THE USE OF DATA ITEMS ON ROLLING
MOMENT DERIVATIVES OF AN AEROPLANE**
1972 2 p

(ESDU-Aircraft-06.01.00) Avail: Issuing Activity

Rolling moment derivatives of an aircraft due to rolling, yawing, and sideslip are discussed. The rolling moments are due to asymmetrical changes in the air flow over the aircraft and the consequent changes in pressure distribution. Procedure is based on principle of calculating effects of various components of the aircraft separately and adding the part derivatives to obtain the overall effect. Author

N73-15980 Engineering Sciences Data Unit, London (England).
**EFFECT OF WING ON ROLLING MOVEMENT DUE TO
YAWING**

Sep. 1972 19 p refs Supersedes ESDU-Aero-A.06.01.02 and ESDU-Aero-A.06.01.08 Sponsored by Roy. Aeron. Soc.

ESDU-72021; ESDU-Aero-A.06.01.02;

ESDU-Aero-A.06.01.08) Copyright. Avail: Issuing Activity CSCL 01A

A method for estimating the contribution of a straight tapered swept wing to the rolling moment derivative due to yawing at lift coefficients for which the flow remains fully attached is presented. The flow is assumed to be subsonic over the whole wing. The basic planform contribution and the effects of dihedral, twist, and deflected trailing edge flaps are considered. Mathematical models are included to amplify the text. Author

N73-15981 Engineering Sciences Data Unit, London (England).
**AERODYNAMIC CHARACTERISTICS OF AEROFOILS IN
COMPRESSIBLE INVISCID AIRFLOW AT SUBCRITICAL
MACH NUMBERS**

Oct. 1972 25 p refs Sponsored by Roy. Aeron. Soc.

(ESDU-72024) Copyright. Avail: Issuing Activity CSCL 01A

A method for estimating a number of aerodynamic characteristics of any given airfoil in compressible inviscid airflow from a knowledge only of the thickness and camber line parameters is presented. The aerodynamic characteristics considered are: (1) lift-curve slope at zero lift, (2) zero-lift incidence, (3) zero-lift pitching moment coefficient, and (4) chordwise position of the aerodynamic center. The geometrical parameters required to obtain estimates for the aerodynamic characteristics are tabulated.

Author

N73-15982 Engineering Sciences Data Unit, London (England).
COMPARISONS WITH EXPERIMENTAL DATA

Sep. 1972 5 p refs

(ESDU-70011-Amend-A) Copyright. Avail: Issuing Activity

The development of aerodynamic coefficients for wings of small thickness in inviscid flow is discussed. The errors introduced by neglecting the effects of thickness and viscosity in determining the lift-curve slope and aerodynamic center position are analyzed.

The analysis is limited to wings at low incidence for Mach numbers up to 0.6. The data are presented as tables and graphs. Author

N73-15983 Pennsylvania Univ., Philadelphia.
**UNSTEADY AIRFOIL THEORY APPLIED TO CAMBERED
BLADES AND TO BLADE ROWS OF HIGH SOLIDITY Ph.D.**
Thesis

Helmut G. W. Naumann 1971 132 p

Avail: Univ. Microfilms Order No. 72-17403

In turbomachinery as rotor blades pass through the wakes of upstream stator blades each blade experiences pressure and lift fluctuations. The first problem discussed deals with the pressure and lift fluctuations of low solidity cascades where the mutual induction effect of blades of the same blade row becomes negligible. The second problem deals with high solidity cascades. Dissert. Abstr.

N73-16986*# Washington Univ., Seattle.

**A TWO-DIMENSIONAL ITERATIVE SOLUTION FOR THE
JET FLAP**

Alan Charles Herold Washington NASA Feb. 1973 48 p refs

(Grant NGL-48-002-010)

(NASA-CR-2190) Avail: NTIS HC \$3.00 CSCL 01A

A solution is presented for the jet-flapped wing in two dimensions. The main flow is assumed to be inviscid and incompressible. The flow inside the jet is considered irrotational and the upper and lower boundaries between the jet and free stream are assumed to behave as vortex sheets which allow no mixing. The solution is found to be in satisfactory agreement with two dimensional experimental results and other theoretical work for intermediate values of momentum coefficient, but the regions of agreement vary with jet exit angle. At small values of momentum coefficient, the trajectory for the jet, as computed by this method, has more penetration than that of other available data, while at high values of momentum coefficient this solution results in less penetration of the jet into the main flow. Author

N73-16987*# National Aeronautics and Space Administration, Washington, D.C.

ON PEAKY AIRFOIL SECTIONS

Junzo Sato Feb. 1973 43 p refs Transl. into ENGLISH from J. Jap. Soc. Aeronaut. Space Sci. (Japan), v. 18, no. 201, Oct. 1970 p 374-388

(NASA-TT-F-749) Avail: NTIS HC \$3.00 CSCL 01A

The development of airfoil configurations to provide shock-free flow at supersonic speeds is discussed. The airfoil design creates local supersonic regions on the surfaces of the airfoil sections. Expansion waves reflected at sonic lines come back to the airfoil surface as compression waves which decelerate the local supersonic flow isentropically to subsonic speeds. A characteristic of the airfoil section is that a negative pressure peak exists close to the leading edge. Schlieren photographs of the shock wave patterns on typical airfoil sections are provided. Graphs of the pressure distribution for various airfoil configurations and conditions of flight are included. P.N.F.

N73-15988*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**SUBSONIC CHARACTERISTICS OF A TWIN-JET SWEEP-
WING FIGHTER MODEL WITH MANEUVERING DEVICES**

Edward J. Ray and Eddie G. Hollingsworth (McDonnell Douglas Co., St. Louis, Mo.) Washington Jan. 1973 292 p refs

(NASA-TN-D-6921; L-8221) Avail: NTIS HC \$3.00 CSCL 01A

An investigation has been conducted at Mach numbers ranging from 0.08 to 0.94 to determine the effects of various combinations of leading-edge slat devices on the static aerodynamic characteristics of a twin-jet swept-wing fighter model. The study also included a determination of the effects of wing leading-edge droop.

trailing-edge chord-extensions, wing fences, and wing-planform and camber modifications. The angle-of-attack range generally extended from about minus 2 deg to 24 deg and the sideslip angles ranged from about minus 6 deg to 13 deg. Author

N73-15991# New York Univ., N.Y. Dept. of Aeronautics and Astronautics.

THE EFFECT OF INJECTION ON BASE DRAG AT TRAN-SONIC SPEED

Renzo Piva and Carlos Dejesus Jul. 1972 59 p refs

(Grant AF-AFOSR-2167-72; AF Proj. 9782)

(AD-751269; NYU-AA-72-19; AFOSR-72-2044TR) Avail: NTIS CSCL 01/1

The problem concerning the possible reduction of the transonic drag for a high speed airplane has been studied. Attention has been focused on decreasing the drag forces on the aft portion of the vehicle. The effect of the injection of a small amount of air in the rear of the model has been experimentally investigated. The alteration of the transonic flow field in the shock-boundary layer interaction region, increases the average pressure on the aft section. The required amount of air was relatively low, because of the high sensitivity of the interaction region to any small change in the flow regime. GRA

N73-15992# West Virginia Univ., Morgantown. Dept. of Aerospace Engineering.

CIRCULATION CONTROL BY STEADY AND PULSED BLOWING FOR A CAMBERED ELLIPTICAL AIRFOIL

Richard E. Walters, Danny P. Myer, and Daniel J. Holt Jul. 1972 116 p refs

(Contract N00014-68-A-0512; NR Proj. 215-163)

(AD-751045; TR-32) Avail: NTIS CSCL 01/3

An experimental investigation was performed on the effectiveness of circulation control in producing additional lift and preventing separation on a cambered elliptical airfoil section with a rounded trailing edge. Steady blowing and pulsed blowing from a slot near the rear of the airfoil were used for circulation control. Downwash studies were conducted for the airfoil using potential flow theory, and Reynolds number effects were studied for the no blowing case. Airfoil surface-pressure distributions are presented for the various test conditions. Author (GRA)

N73-15993 Engineering Sciences Data Unit, London (England). **LOW SPEED LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF AIRCRAFT IN GROUND EFFECT**

Oct. 1972 21 p refs Supersedes ESDU-Aero-A.01.01.01

Sponsored by Roy. Aeron. Soc.

(ESDU-72023; ESDU-Aero-A.01.01.01) Copyright. Avail: Issuing Activity CSCL 01B

A method for estimating the changes in the lift curve, drag, tail lift, and downwash from the wing of an aircraft due to ground effect in incompressible flow is presented. Static treatment of the aerodynamics of aircraft flying in ground effect is defined. The changes in the free air conditions on approaching the ground at constant aircraft lift coefficient by changing incidence are examined. Author

N73-15994 Stanford Univ., Calif.

COMPUTATIONAL METHODS FOR THE SYNTHESIS OF ROTARY WING VTOL AIRCRAFT CONTROL SYSTEMS Ph.D. Thesis

Wilton Earl Hall 1971 257 p

Avail: Univ. Microfilms Order No. 72-11564

A design procedure is developed which models a rotary-wing VTOL aircraft as two coupled rigid bodies which represent the rotor and fuselage respectively. Previous design approaches for the synthesis of VTOL aircraft controllers have treated rotor and fuselage as dynamically uncoupled systems, and generally the rotor dynamics have been neglected in synthesizing the fuselage controls. Only the low-speed flight regime around hover is considered for this design. The equations for the rotor dynamics and rotor forces on the fuselage are obtained from an analysis of blade motions. The controls-fixed dynamic response of the two rigid body approximation is determined for a typical vehicle

with an articulated rotor and also with a hingeless rotor. A controller has been designed for the two rigid body approximation using eigenvector decomposition of the Euler-Lagrange equations of quadratic synthesis. Dissert. Abstr.

N73-15995 Duke Univ., Durham, N.C.

DYNAMIC INTERACTIONS OF HIGH SPEED TRACKED AIR CUSHION VEHICLES WITH THEIR GUIDEWAYS: A PARAMETRIC STUDY Ph.D. Thesis

Sherrill Bost Biggers, Jr. 1971 142 p

Avail: Univ. Microfilms Order No. 72-11066

A mathematical model of a tracked air cushion vehicle and its guideway is formulated in order to investigate the vertical dynamic response of the vehicle-guideway system due to high speed vehicle passage. The vehicle is modeled as an arbitrary number of mass systems traveling in tandem, each system consisting of a lower mass (air cushion housing and chassis) and an upper mass (passengers and isolated passenger compartment). A train of vehicles can be represented by using a large number of mass systems in tandem. The vehicle load is transmitted to the guideway as a uniform, distributed pressure which varies in magnitude according to the vehicle vertical accelerations. The guideway is modeled as a series of simply supported Bernoulli-Euler beams with provisions for an elastic subgrade, combined structural and external damping, and a uniform axial compressive force. Dissert. Abstr.

N73-15996 North Carolina State Univ., Raleigh.

DESIGN FOR IMPROVEMENTS TO STATIC PERFORMANCE AND LATERAL-DIRECTIONAL DYNAMIC STABILITY OF A CONSTANT ATTITUDE LIGHT AIRCRAFT Ph.D. Thesis

Douglas Eugene Humphreys 1971 108 p

Avail: Univ. Microfilms Order No. 72-8939

A design study was conducted to improve static performance and lateral-directional dynamic stability for a light aircraft. Design modifications are developed for a PA28-235C Piper Cherokee to enable it to fly at constant pitch attitude during all modes of flight. Lift modulation over the flight profile is accomplished through the use of full-span Fowler flaps. Lateral control is also provided by these full-span flaps. Improvements in static performance are accomplished by reducing the wing area by 25 percent and making greater utilization of propeller performance. The lateral-directional dynamic stability is improved by the design of a stability augmentation system. This system utilizes sideslip and bank angle feedback. Fast acting servos and electrical compensator networks are used to provide rapid bank angle response and to eliminate unwanted disturbances from sidegusts. Dissert. Abstr.

N73-15997 Case Western Reserve Univ., Cleveland, Ohio.

AN OPTIMAL CONFIGURATION DESIGN OF LIFTING SURFACE TYPE STRUCTURES UNDER DYNAMIC CONSTRAINTS Ph.D. Thesis

Hirokazu Miura 1972 222 p

Avail: Univ. Microfilms Order No. 72-18717

An optimization, intended to be used in the preliminary design stage, of the structural configuration for a simplified model of a supersonic airplane wing is undertaken. The simplified plan view shape, the wing depth distribution and the skin panel thickness distribution are determined so that an objective function composed of a linear combination of the weight of the wing and the aerodynamic drag is minimized. In addition to static constraints, (yield stress, displacement, angle of attack and the required gross lift), natural vibration frequency and supersonic flutter speed are considered as constraints. A wing is considered to be a sandwich plate of variable thickness. By smearing all inhomogeneities, the skin panels and the sandwiched core are considered to be orthotropic, homogeneous materials. Distinctly large masses such as engines are considered to be concentrated masses at specified points. Dissert. Abstr.

N73-15998# Massachusetts Inst. of Tech., Cambridge. Charles Stark Draper Lab.

SOME EFFECTS OF BIAS ERRORS IN REDUNDANT FLIGHT

CONTROL SYSTEMS

Robert F. Stengel Jun. 1972 12 p refs
(Contract NAS9-10268)

(NASA-CR-130354; E-2688) Avail: NTIS HC \$3.00 CSCI
01B

The controllability and steady-state response of parallel-redundant flight control systems are examined. It is found that state components which appear in the parallel signal paths, or individual actuator commands, are not controllable, although the sum of the command signals is well-behaved. If the response modes associated with these components are not stable, bias errors can cause the components to diverge, leading to the possibility of nuisance trips in failure detection/isolation logic and eventual control system lockup (at saturation). Combining the inputs to the control computers assures that sensor bias will not cause divergence, while cross-strapping control strings bounds divergent response to all bias error inputs. Results of numerical solutions confirm the problem and its solutions.

Author

N73-15999# National Transportation Safety Board, Washington D.C.

AIRCRAFT ACCIDENT REPORT: CAPITOL INTERNATIONAL AIRWAYS, INCORPORATED, DC-8-63F, N4909C; ANCHORAGE, ALASKA, 27 NOVEMBER 1970

29 Mar. 1972 48 p

(NTSB-AAR-72-12) Avail: NTIS HC \$4.50

A Douglas DC-8-63F aircraft crashed following an unsuccessful takeoff attempt from the Anchorage International Airport Anchorage, Alaska, on 27 Nov. 1970. The flight was being operated as a Military Airlift Command (MAC) contract flight from McChord Air Force Base, Tacoma, Washington, to Cam Ranh Bay, Republic of South Viet Nam, with en route fueling stops at Anchorage, Alaska, and Yokota Air Base, Japan. There were 219 military passengers and a crew of 10 aboard the aircraft. Forty-six passengers and one flight attendant received fatal injuries in the post-crash fire. At the time of the takeoff, precipitation, in the form of freezing drizzle, was occurring at the airport and the runway was covered with a light coating of ice. Evidence of tire skid marks, degraded rubber and shredded tire casings were found over most of the length of the runway. The probable cause of this accident was the failure of the aircraft to attain the necessary airspeed to effect liftoff during the attempted takeoff.

Author

N73-16000# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

AIRCRAFT INCIDENT REPORT: EASTERN AIR LINES, INCORPORATED, BOEING 727-100, N8168G FLIGHT 9701, ATLANTA, GEORGIA, 21 DECEMBER 1971

26 Jul. 1972 18 p ref

(NTSB-AAR-72-22) Avail: NTIS HC \$3.00

A Boeing 727 aircraft struck portions of the approach light system during landing approach at Atlanta International Airport, Georgia on 21 December 1971. Minor damage occurred to the aircraft flaps and landing gear. The cause of the accident was stated as an unexpected and undetected divergence of the aircraft from the glide slope centerline induced by a malfunction of the automatic pilot. The divergence occurred at an altitude where safe recovery could have been made, however, the preoccupation of the pilots with establishing an outside visual reference precluded timely recognition of the divergence.

Author

N73-16001# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AVIATION. ISSUE NO. 3: 1971 ACCIDENTS

29 Sep. 1972 485 p

(NTSB-BA-72-6) Avail: NTIS HC \$26.25

Selected aircraft accident reports, in brief format, occurring in U.S. Civil Aviation operations during calendar year 1971 are presented. The 900 General Aviation accidents contained in this publication represent a random selection. This publication is issued irregularly, normally six times each year. The brief format presents the facts, conditions, circumstances, and probable cause(s) for

each accident. Additional statistical information is tabulated by type of accident, phase of operation, kind of flying, injury index, aircraft damage, conditions of light, pilot certificate, injuries, and causal factors.

Author

N73-16002# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AVIATION. ISSUE NO. 4: 1971 ACCIDENTS

4 Dec. 1972 512 p

(NTSB-BA-72-7) Avail: NTIS HC \$27.75

Selected aircraft accident reports, in brief format, occurring in U.S. Civil Aviation operations during calendar year 1971 are presented. The General Aviation accidents contained in this publication represent a random selection. The brief format presents the facts, conditions, circumstances, and probable cause(s) for each accident. Additional statistical information is tabulated by type of accident, phase of operation, kind of flying, injury index, aircraft damage, conditions of light, pilot certificate, injuries, and causal factors.

Author

N73-16003# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: ROSS AVIATION, INCORPORATED, BEECHCRAFT 86-B80, QUEEN AIR, N841NS, ALBUQUERQUE, NEW MEXICO, 19 MAY 1972

13 Dec. 1972 19 p

(NTSB-AAR-72-32) Avail: NTIS HC \$3.00

A Beechcraft Queen Air aircraft, on a scheduled air taxi flight, crashed shortly after takeoff at the Albuquerque, New Mexico airport on 19 May 1972. The aircraft was destroyed by impact forces and post-impact fire. The probable cause of the accident was inadvertent opening of the forward cargo compartment door with resulting damage to the left propeller. Loss of power from the left engine at a critical stage of flight caused the aircraft to crash.

Author

N73-16004# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: PUERTO RICO INTERNATIONAL AIRLINES (PRINAIR), INCORPORATED, DEHAVILLAND DH-114, N564PR, PONCE, PUERTO RICO, 24 JUNE 1972

20 Dec. 1972 13 p

(NTSB-AAR-72-34) Avail: NTIS HC \$3.00

A DeHavilland Heron DH-114 crashed on the Mercedita Airport, Ponce, Puerto Rico, during an attempted go-around after landing on Runway 29, on 24 June 1972. The probable cause of this accident was the presence of an unauthorized vehicle on the runway which caused the pilot to attempt a go-around after touchdown to avoid a collision. The maneuver resulted in an overrotation of the aircraft at too low an airspeed to sustain flight.

Author

N73-16005# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: EASTERN AIRLINES, INCORPORATED, DC-9-31, N8961E, FORT LAUDERDALE, FLORIDA, 18 MAY 1972

13 Dec. 1972 36 p

(NTSB-AAR-72-31) Avail: NTIS HC \$4.00

A DC-9 aircraft was involved in a landing accident on May 18, 1972, at approximately 1521 eastern daylight time, at the Fort Lauderdale-Hollywood International Airport, Fort Lauderdale, Florida. The accident occurred following a straight-in localizer approach when the aircraft touched down hard on the runway, resulting in the failure of the main landing gear and the separation of the tail section from the aircraft. The aircraft was destroyed by subsequent ground fire. At the time of the accident, heavy rainshowers, associated with thunderstorm activity, were occurring at the airport. The probable cause of this accident was the decision of the pilot to initiate and continue an instrument approach under weather conditions which precluded adequate visual reference and the faulty techniques used by the

pilot during the landing phase of that approach. The flightcrew's nonadherence to prescribed operational practices and procedures compromised the safe operation of the flight. Author

N73-16006# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: AERO TAXI, BEECH E18S, N42A, CLEVELAND, OHIO, 22 JUNE 1972

20 Dec. 1972 24 p
(NTSB-AAR-72-33) Avail: NTIS HC \$3.25

A Beech Aircraft, Model E18S, on an air taxi revenue cargo flight, crashed into a residential area at approximately 0840 eastern daylight time, June 22, 1972. The accident occurred shortly after takeoff from Cleveland-Hopkins International Airport, Cleveland, Ohio. The pilot, the only occupant of the aircraft, was fatally injured. Two houses were damaged by aircraft impact and fire, but no injuries were sustained by persons on the ground. The probable cause of this accident was the in-flight failure of the left wing which resulted from a preexisting fatigue crack in the left-wing lower spar cap. The fatigue crack was present during inspections of the spar cap for cracks conducted prior to the accident, but it was not detected during these inspections.

Author

N73-16007*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

COMPUTER PROGRAMS FOR ESTIMATION OF STOL TAKEOFF, LANDING, AND STATIC PERFORMANCE

Susan E. Post Dec. 1972 66 p refs Prepared in cooperation with Army Air Mobility R and D Lab., Moffett Field, Calif.
(NASA-TM-X-62217) Avail: NTIS HC \$5.50 CSCL 01B

A set of computer programs has been developed for evaluating the performance of powered-lift STOL aircraft. Included are a static performance summary and dynamic calculations of takeoff and landing performance. The input, output, options, and calculations for each program are described. The programs are written in FORTRAN IV and are currently available on TSS 360. Three independent sections are presented corresponding to the three programs: (1) static performance, (2) takeoff performance, and (3) landing performance.

Author

N73-16008*# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

MODELING OF AIRPLANE PERFORMANCE FROM FLIGHT-TEST RESULTS AND VALIDATION WITH AN F-104G AIRPLANE

Robert T. Marshall and William G. Schweikhard Washington Feb. 1973 30 p refs
(NASA-TN-D-7137; H-723) Avail: NTIS HC \$3.00 CSCL 01B

A technique of defining an accurate performance model of an airplane from limited flight-test data and predicted aerodynamic and propulsion system characteristics is developed. With the modeling technique, flight-test data from level accelerations are used to define a 1g performance model for the entire flight envelope of an F-104G airplane. The performance model is defined in terms of the thrust and drag of the airplane and can be varied with changes in ambient temperature or airplane weight. The model predicts the performance of the airplane within 5 percent of the measured flight-test data. The modeling technique could substantially reduce the time required for performance flight testing and produce a clear definition of the thrust and drag characteristics of an airplane.

Author

N73-16009*# Aerospace Corp., El Segundo, Calif. Air Transportation Group.

STUDY OF V/STOL AIRCRAFT IMPLEMENTATION. VOLUME 2: APPENDICES

A. Androsky, S. C. Miller, J. A. Neiss, W. J. Portenier, and H. M. Webb Nov. 1972 315 p refs
(Contract NAS2-6473)
(NASA-CR-114518; ATR-73(7303)-1-Vol-2-App) Avail: NTIS HC \$17.75 CSCL 01B

An analysis of V/STOL aircraft implementation and utilization is presented. The subjects discussed are: (1) short-haul air

transportation requirements, (2) available aircraft technology, (3) aircraft production requirements, (4) airport requirements, (5) roles and responsibilities, and (6) cost and funding. Author

N73-16010*# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

EXPLICIT DETERMINATION OF LATERAL-DIRECTIONAL STABILITY AND CONTROL DERIVATIVES BY SIMULTANEOUS TIME VECTOR ANALYSIS OF TWO MANEUVERS

Glenn B. Gilyard Washington Feb. 1973 12 p refs
(NASA-TM-X-2722; H-751) Avail: NTIS HC \$3.00 CSCL 01B

An extension of the time vector technique for determining stability and control derivatives from flight data is formulated. The technique provides for explicit determination of derivatives by means of simultaneous analysis of two maneuvers which differ by a dependent control input. The control derivatives for the dependent input are also explicitly determined. This extended technique is preferable to the application of the time vector method to single maneuvers in that no estimates of derivatives are required. An example illustrating the application of the technique is given.

Author

N73-16011*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

LOW-FREQUENCY REAR QUADRANT NOISE OF A TURBOJET ENGINE WITH EXHAUST DUCT MUFFLING

Richard P. Woodward and Gene L. Minner Washington Feb. 1973 21 p refs
(NASA-TM-X-2718; E-7202) Avail: NTIS HC \$3.00 CSCL 20A

A J-65 engine was run with a tuned sound-absorbing exhaust duct to study the internal and jet components of rear quadrant noise. Full muffler, hard wall duct, and regular production engine configurations were tested. The jet exhaust velocities were subsonic. The use of the exhaust muffler extended the relation between the jet noise and the eighth power of the jet velocity to lower velocities than for the hard wall duct.

Author

N73-16012*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

THE EFFECTS OF CONFIGURATION CHANGES ON THE AERODYNAMIC CHARACTERISTICS OF A FULL-SCALE MOCKUP OF A LIGHT TWIN ENGINE AIRPLANE

Marvin P. Fink, James P. Shivers, H. Douglas Greer, and James L. Megrail (Army Air Mobility Res. and Develop. Lab., Fort Eustis, Va.) Washington Sep. 1972 223 p refs
(NASA-TN-D-6896; L-8375) Avail: NTIS HC \$3.00 CSCL 01C

Wind tunnel tests of a full-scale model of a light twin engine aircraft were conducted. The angle of attack was varied from minus 4 degrees to plus 20 degrees. The sideslip range was plus or minus 8 degrees. Thrust coefficients were 0, 0.20, and 0.44. Tests were made with various nacelle configurations, modes of propeller rotation, orientation of the thrust axis, and airfoil section at Reynolds numbers of 2.96 times one million and 2.05 times one million.

Author

N73-16013*# Mount Auburn Research Associates, Inc., Newton Upper Falls, Mass.

GODUNOV METHOD AND COMPUTER PROGRAM TO DETERMINE THE PRESSURE AND FLOW FIELD ASSOCIATED WITH A SONIC BOOM FOCUS

Lee W. Parker and Robert G. Zalosh Washington NASA Jan. 1973 109 p refs
(Contract NAS1-10276)

(NASA-CR-2127) Avail: NTIS HC \$3.00 CSCL 20A

A computer method has been developed to calculate the flow field associated with sonic boom focusing. Solutions are obtained for focussing caused by localized cold spots in the atmosphere, as well as for N-waves with concave fronts. Results include focus factors and the length scales of the focal region. Both strong and weak shock waves are studied.

Author

N73-16014*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
PITCH ATTITUDE, FLIGHT PATH, AND AIRSPEED CONTROL DURING APPROACH AND LANDING OF A POWERED LIFT STOL AIRCRAFT

James A. Franklin and Robert C. Innis Dec. 1972 68 p refs (NASA-TM-X-62203) Avail: NTIS HC \$5.50 CSCL 01C

Analytical investigations and piloted moving base simulator evaluations were conducted for manual control of pitch attitude, flight path, and airspeed for the approach and landing of a powered lift jet STOL aircraft. Flight path and speed response characteristics were described analytically and were evaluated for the simulation experiments which were carried out on a large motion simulator. The response characteristics were selected and evaluated for a specified path and speed control technique. These characteristics were: (1) the initial pitch response and steady pitch rate sensitivity for control of attitude with a pitch rate command/ attitude hold system, (2) the initial flight path response, flight path overshoot, and flight path-airspeed coupling in response to a change in thrust, and (3) the sensitivity of airspeed to pitch attitude changes. Results are presented in the form of pilot opinion ratings and commentary, substantiated where appropriate by response time histories and aircraft states at the point of touchdown. Author

N73-16015*# Massachusetts Inst. of Tech., Cambridge, Aeroelastic and Structures Research Lab.
INVESTIGATION OF SOME PARAMETERS AFFECTING THE STABILITY OF A HINGELESS HELICOPTER BLADE IN HOVER

Peretz Friedmann Aug. 1972 19 p refs

(Contract NAS2-6175)

(NASA-CR-114525; ASRL-TR-166-4) Avail: NTIS HC \$3.00 CSCL 01B

Equations of motion are used to investigate the effects of the choice of the mode shape and built-in coning angle on the stability boundaries of hingeless blades in hover. The results obtained indicate that the stability boundaries are dependent upon the mode shape to a considerable degree. It was also found that positive built-in coning is usually destabilizing while a negative amount of built-in coning can be quite stabilizing.

Author

N73-16016# Messerschmitt-Boelkow-Blohm G.m.b.H., Hamburg (West Germany).
RECENT STUDIES ON METEOROLOGICAL ICING PARAMETERS [NEUERE UNTERSUCHUNGEN AUF DEM GEBIET DER METEOROLOGISCHEN VEREISUNGSPARAMETER]

W. Kleuters 12 Sep. 1972 37 p refs In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972 (MBB-UH-11-72-O; DGLR-Paper-72-109) Avail: NTIS HC \$4.00

Natural ice formation conditions were investigated during test flights of the Transall C-160, in 1969 and 1970. The meteorological icing parameters, free water content, drop diameter and temperature have been measured. A special device was used for measuring free water content, which was reliable at high temperature and high water content. The data were evaluated statistically according to NACA/TN2738 and the results compared with the values in FAR25, Appendix C. It is shown that for high temperature and water content there are great differences, which can be traced back to the measuring equipment used by NACA, a rotating multicylinder, which does not function satisfactorily for high water content.

Author (ESRO)

N73-16017# Messerschmitt-Boelkow-Blohm G.m.b.H., Hamburg (West Germany).
COMPARISON BETWEEN STOL AIRCRAFT WITH MECHANICAL HIGH-LIFT SYSTEMS AND STOL AIRCRAFT WITH BLOWN FLAP WINGS [STOL-FLUGZEUGE MIT MECHANISCHEN HOCHAUFTRIEBSYSTEMEN IM VERGLEICH ZU STOL-FLUGZEUGEN MIT BLASKLAPPENFLUEGELN]

E.-A. Bielefeldt 20 Sep. 1972 35 p refs In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972

(MBB-UH-12-72-O; DGLR-Paper-72-057) Avail: NTIS HC \$3.75

The net lift of modern mechanical high lift devices and externally blown flaps applied to STOL aircraft is compared. The possibilities of achieving higher aerodynamic efficiencies with these high lift devices are discussed. Aerodynamic installation problems and influence of the installation weights of several devices on the net lift are surveyed. The net lift, of complex mechanical and blown flap systems is determined for a STOL aircraft, which has a wing loading of 370 kp/sq m and a maximal lift coefficient in trimmed situation of about 3.5. It is shown that for this case mechanical high lift devices are superior to blown flaps.

Author (ESRO)

N73-16018# Messerschmitt-Boelkow-Blohm G.m.b.H., Hamburg (West Germany).
INFLUENCE OF AIRWORTHINESS REGULATIONS ON TAKEOFF AND LANDING PERFORMANCE OF QSTOL AIRCRAFT [EINFLUSS VON LUFTTUECHTIGKEITSVORSCHRIFTEN AUF DIE START- UND LANDELEISTUNGEN VON QSTOL-FLUGZEUGEN]

Heinz G. Klug 20 Sep. 1972 25 p In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972 (MBB-UH-13-72-O; DGLR-Paper-72-056) Avail: NTIS HC \$3.25

The decisive influence of the requirements and assumptions with regard to takeoff and landing performance on the design of QSTOL aircraft is shown by using a typical example of an aircraft with externally blown flaps. This aircraft would need less than 500 m runway length according to one set of rules, and according to another set nearly 1000 m. The influence of different regulations on the determination of the lowest allowable velocities in flying over obstacles is represented and explained. Aircraft with blown flaps are very sensitive to this, and the whole comparison between different concepts can be distorted. A physically based set of regulations is required.

Author (ESRO)

N73-16019# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
STUDY OF FLIGHT DYNAMICS USING PROBLEM ORIENTED PROGRAM LANGUAGES [UNTERSUCHUNG DER FLUGZEUGDYNAMIK MIT HILFE BLOCKORIENTIERTER PROGRAMMIERSPRACHEN]

H. Friedrich, H. Munser, and W. Kohl Bonn Bundeswehramt 1972 159 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung (BMVg-FBWT-72-21) Avail: NTIS HC \$10.00; Bundeswehramt 25 DM

A problem oriented program was tested for its application to digital simulation in flight dynamics investigations. These investigations are based on conventional computing methods with small perturbations theory and on simulation. A digital simulation language is suggested as a link between the two methods. The possibilities of CSMP, a problem oriented IBM program, were examined with the aid of two reference aircraft, Fiat G-91 and Dornier Do-31. The programming and testing are described, and all the possibilities available in flight dynamics with this computing technique are demonstrated. Cost aspects are mentioned.

ESRO

N73-16020# Intermetrics, Inc., Cambridge, Mass.
PWI (PILOT WARNING INDICATORS) SYSTEMS SURVEY

Final Report, Apr. - Nov. 1971

James H. Flanders, Peter A. Grundy, and Neal A. Carlson Nov. 1971 151 p refs

(Contract DOT-TSC-188)

(PB-212496; DOT-TSC-188-2) Avail: NTIS HC \$3.00 CSCL 01B

The survey is presented, using a compilation, classification, and review of 176 documents related to PWI and CAS research and development. Subject categories include: CAS system references; PWI system references; proceedings and literature searches; facilities and programs; and atmospheric physics. A multidimensional classification code for CAS and PWI systems is also included.

Author (GRA)

N73-16021# Princeton Univ., N.J.
HELICOPTER STATION KEEPING Final Task Report, Sep. 1966 - 30 Dec. 1971

Theodor A. Duker Sep. 1972 95 p refs
 (Contract DA-28-043-AMC-02412(E); DA Proj. 1H1-62202-A-219)
 (AD-751459; ECOM-02412-9) Avail: NTIS CSCL 01/2

A discussion of all aspects of formation flight, from initiation to termination, leads to an emphasis on the station keeping control loop. The most essential topics are brought into focus in order to reveal and to emphasize the basic relationships which must be considered in decisions about formation flight system features and requirements. The significance of leader-to-follower data communication is explored in detail. Nominal station keeping trajectories are defined in terms of the motion of a nominal point coordinate system. The information available to the follower determines his ability to calculate the location and orientation of the nominal coordinate system, i.e., his position errors. The need to know the reference orientation at low speeds and hover is shown. Acceleration errors are estimated based on a simple model for the positioning control loop, and relatively narrow ranges of gains and bandwidth are found feasible. Improvements can be made if leader information is available and utilized.

Author (GRA)

N73-16022# Princeton Univ., N.J.
A DYNAMIC HELICOPTER PERFORMANCE AND CONTROL MODEL Final Task Report, 1 Sep. 1966 - 30 Dec. 1971

G. J. Born, D. Carico, and E. J. Durbin Aug. 1972 66 p refs
 (Contract DA-28-043-AMC-02412(E); DA Proj. 1H1-62202-A-219)
 (AD-751460; ECOM-02412-11) Avail: NTIS CSCL 01/3

The report gives the results of the development of a dynamic helicopter performance and control model. The dynamic performance model is obtained by using the force and rotor aerodynamic equations. This performance model together with the moment balance and control equations are used as a basis for a helicopter control model. This model can be used for over relatively large speed range and varying rotor rpm. As an example, an analog computer simulation is made for a UH-1C helicopter, performing a steep descent maneuver, close to autorotation boundary.

Author (GRA)

N73-16023# ARO, Inc., Arnold Air Force Station, Tenn.
POST-STALL TESTING OF AIRCRAFT WITH A WIND TUNNEL CAPTIVE SYSTEM Final Report, Feb. - Jun. 1972

J. R. Milillo AEDC Nov. 1972 21 p refs
 (Contract F40600-73-C-0004; ARO Proj. PW5284)
 (AD-751461; ARO-PWT-TR-72-115; AEDC-TR-72-126) Avail: NTIS CSCL 01/3

High-speed aircraft may have unsatisfactory stall characteristics and the aircraft may be lost because of the uncontrolled flight gyrations encountered in attempting to maneuver in the stalled flight regime. Results are presented of a study to determine the feasibility of using a captive technique in a wind tunnel to study aircraft post-stall characteristics and to define boundaries for maintaining controlled flight of the aircraft. The technique appears feasible but needs to be developed by conducting pilot tests in an existing facility.

Author (GRA)

N73-16024# Defense Documentation Center, Alexandria, Va.
AIRCRAFT LANDINGS Report Bibliography, Jan. 1970 Apr. 1972

Nov. 1972 156 p refs
 (AD-751800; DDC-TAS-72-50) Avail: NTIS CSCL 01/2

The bibliography contains unclassified references on Aircraft Landings. These references deal with carrier controlled radar, carrier landings, instrument landings, approach, night landings, ground controlled radar, landing lights, display systems, control systems, glide path systems, human factors, and landing lights. Corporate Author-Monitoring Agency, Subject, Personal Author and Title Indexes are provided.

Author (GRA)

N73-16025# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
FIRE DETECTION SYSTEM PERFORMANCE IN USAF

AIRCRAFT Final Technical Report, Mar. - Sep. 1971
 Charles Delaney Aug. 1972 26 p refs
 (AD-751346; AFAPL-TR-72-49) Avail: NTIS CSCL 01/3

The report is concerned with the determination of the performance of fire detection systems in USAF aircraft. Data on false fire warnings and aircraft engine nacelle fires were taken from Air Force accident/incident reports. These data included the time period 1965 through 1970 and is restricted to noncombat related accidents/incidents. Analysis of the data showed that false fire warnings are a major problem in the majority of USAF aircraft (83% of all reported alarms are false). These false fire warnings resulted in damage or destruction to aircraft as well as crew injuries/fatalities. In addition, it was found that in approximately 50% of the engine nacelle fires, where the performance of the detection system could be determined, the system did not provide an alarm. It was also found that the fire detection system in a number of aircraft had been partially or totally removed to reduce or eliminate the false fire warning problem. As a consequence the majority of the fires which occurred in these aircraft were not detected.

Author (GRA)

N73-16026# Dunlap and Associates, Inc., Darien, Conn.
PREDICTIVE AND ADAPTIVE PROCESSES IN THE CONTROL OF AIR FORCE SYSTEMS Final Report

Charles R. Kelley 30 Sep. 1972 19 p
 (Contract F44620-72-C-0006; AF Proj. 9778)
 (AD-751306; AFOSR-72-2037TR) Avail: NTIS CSCL 01/3

The project has been concerned with prediction and adaptation in control of systems such as military aircraft. The processes were explored in human operators, in adaptive displays for the human operator and in a means for coupling manual with automatic control. The latter development, termed automanual control, was mechanized and tested in the laboratory. Automanual control with a predictor instrument proved superior to four other modes of control to which it was compared.

Author (GRA)

N73-16027# Boeing Co., Morton, Pa. Vertol Div.
USE OF THE FINITE ELEMENT DAMPED FORCED RESPONSE STRAIN ENERGY DISTRIBUTION FOR VIBRATION REDUCTION

John J. Sciarra and Robert G. Ricks 1972 30 p refs Presented at AROD Mil. Theme Rev. The Helicopter and V/STOL Aircraft Res. Conf., Moffett Field, Calif., 26-27 Sep. 1972
 (Contract DAHC04-71-C-0048)
 (AD-751809; AROD-9621-1-E) Avail: NTIS CSCL 01/3

Expressions for the vibratory strain energy distribution using the damped forced response (DFR) are developed. The modes above and below the excitation frequency are analyzed separately. The results are then combined to establish criteria for structural optimization. A helicopter forward pylon structural model is used to demonstrate the advantages of the DFR strain energy concept for structural vibrational optimization.

Author (GRA)

N73-16028# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
COORDINATE STABILIZATION FOR A FLEXIBLE AIRCRAFT DURING FLIGHT IN A TURBULENT ATMOSPHERE

V. V. Udilov 8 Sep. 1972 13 p refs Transl. into ENGLISH from the mono. "Primenenie Invariantnykh Sistem Avtomaticheskogo Upravleniya" Moscow, Izd-vo Nauka, 1970 p 221-231
 (AD-751148; FTD-HT-23-863-72) Avail: NTIS CSCL 01/4

The problem is considered of automatically controlling aircraft altitude and pitch angle in the duck system. The aircraft dynamics are described by a system of linear differential equations with constant coefficients: three equations of motion of the center of gravity and rotation of the aircraft as a solid body, and a combination of equations for the flexible oscillations of an elastic fuselage in the plane of longitudinal symmetry. It is assumed that the autopilot acts on the flaps in changing the pitch and attack angles, the generalized coordinates characterizing the bending oscillations of the fuselage, and the nose controlling surface, as well as in changing the slope of the trajectory.

Author (GRA)

N73-16029# Lockheed Missiles and Space Co., Sunnyvale, Calif. Ground Vehicle Systems.

HIGH PERFORMANCE HELICOPTER HOIST PROGRAM Final Report

Louis J. Lawson, J. H. Duddy, R. R. Gilbert, M. R. Helvey, E. H. Jacobsen, R. Ruth, and W. T. Wada Aug. 1972 169 p refs (Contract DAAD05-72-C-0099)

(AD-751217; LMSC-D267477; LWL-CR-02M72) Avail: NTIS CSCL 01/3

The report presents a feasibility study on a flywheel powered personnel rescue hoist for helicopters. It includes investigations of flywheel configurations, materials, and associated equipment including bearings, seals, and pumps. Also included are discussions of human factors considerations and design considerations affecting component selection, hoist configuration, and hoist installation. Particular attention is given to the capability of a 13.5-lb, 73.5 w-hr flywheel to provide the short duration high power required to affect rescue hoisting speed as high as 500 ft per min. without overtaxing the helicopter's limited accessory power capacity. Author (GRA)

N73-16215 Texas Univ., Austin.

THEORETICAL EFFECTS OF POROSITY AND ANGLE OF ATTACK ON JET STRETCHER PERFORMANCE Ph.D. Thesis

Ben Russell Eppright, Jr. 1971 117 p

Avail: Univ. Microfilms Order No. 72-11341

Two methods of improving the usefulness of a jet stretcher are investigated. Both methods attempt to make possible the use of a jet stretcher designed for a body at zero angle of attack with the same body at small angles of attack. The two methods are: (1) making the jet stretcher walls porous, and (2) placing the jet stretcher at an angle of attack. The above methods are investigated theoretically by solving the supersonic, three-dimensional flow field about the body with the jet stretcher and without the jet stretcher. The solutions are obtained numerically using the Method of Characteristics for an ideal, inviscid gas. The derivation of the finite difference equations is included. The results are first compared to experimental data to establish the accuracy of the solution. It is found that the solution is very accurate. The solutions for the body with the jet stretcher are then compared to the solutions for the body without the jet stretcher. Dissert. Abstr.

N73-16216 Stanford Univ., Calif.

MODELING OF A SATELLITE AIRPORT SYSTEM FOR LARGE METROPOLITAN AREAS: A SYSTEMS ANALYSIS Ph.D. Thesis

Inder Kumar Sud 1971 195 p

Avail: Univ. Microfilms Order No. 72-11674

The satellite airport system is presented as a possible solution to the growing congestion problem at the major metropolitan airports. The system visualizes a large airport as the hub of a ring of satellites around it. The satellite airport system includes conventional take-off and landing (CTOL) airports, short take-off and landing (STOL) ports, and collection-ports linked to the main airport by means of transportation links. It is proposed that the short-haul and some of the medium-haul passengers would be handled by the satellite airports and the remaining passengers would enter the system at one of the satellite collection-ports, and then would be transported to the main airport. A system approach is proposed to analyze the satellite airport concept for large metropolitan areas. Various socioeconomic factors that influence the airport location are considered. A mathematical model formulates the problem as a fixed charge selection-allocation problem. Dissert. Abstr.

N73-16222# Landing Aids Experiment Station, Arcata, Calif.

THERMAL FOG DISPERSAL MANUAL

Dec. 1972 76 p refs Reprinted Sponsored by AF, Navy, Civil Aeron. Admin., CAB, Air Trans. Assoc., and Air Line Pilots Assoc.

(Contract C13cA-136)

(FAA-RD-72-138) Avail: NTIS HC \$6.00

The requirements, basic principles of design, construction, operation, and maintenance of a thermal fog dispersal system are described. The recommended installation is a high pressure

system wherein fuel is pumped to the burner lines at pressures over 1000 p.s.i., atomized by passing through an orifice plate in the burner head, and automatically ignited. Atmospheric heat requirements for the dissipation of fog, the effect of winds on system design, and the interface between aircraft and fog dispersal system operations are analyzed. Author

N73-16226# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.

NONLINEAR AND FINITE PAD LENGTH PERFORMANCE OF VEHICLE AIR CUSHION SUSPENSIONS

D. N. Wormley, D. P. Garg, and A. B. Boghani Feb. 1972 130 p refs

(Contract DOT-FR-10007)

(PB-212705; EPL-72-72966-1; FRA-RT-73-6) Avail: NTIS HC \$3.00 CSCL 13B

Nonlinear and small perturbation linear models for the one-dimensional heave motion of a basic flexible-skirted air cushion suspension are formulated. A study of linear and nonlinear model characteristics under transient guideway and external force inputs is conducted to determine over what range of cushion configurations, operating conditions, and input disturbance levels a linear model provides a good approximation to the nonlinear cushion model. The performance of a finite pad length suspension on a guideway containing random irregularities is determined. To illustrate the design information resulting from the transient performance and finite pad length study, the prototype designs of suspensions for intraurban and intercity vehicles are discussed. Author (GRA)

N73-16229# Naval Postgraduate School, Monterey, Calif.

IMPLEMENTATION OF A FIXED BASE SPIN SIMULATOR M.S. Thesis

Bruce Holladay Kenton Sep. 1972 139 p refs

(AD-751644) Avail: NTIS CSCL 14/2

The report discusses the design and implementation of a fixed-based spin simulator and the results derived from conducting preliminary spin tests on the simulator. The central piece of equipment in the simulator was a hybrid computer in which the analog computer solved the equations of motion while the digital computer performed the tasks of program control and aerodynamic data storage. The visual display consisted of a computer-drawn picture on a graphics terminal, while pilot control was obtained by use of a simulated cockpit situated in front of the graphics terminal. Author (GRA)

N73-16247*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

DESIGN AND FLIGHT TESTING OF A NULLABLE COMPRESSOR FACE RAKE

Jon K. Holzman and Gordon A. Payne Washington Jan. 1973 17 p refs

(NASA-TN-D-7162; H-733) Avail: NTIS HC \$3.00 CSCL 20D

A compressor face rake with an internal valve arrangement to permit nulling was designed, constructed, and tested in the laboratory and in flight at the NASA Flight Research Center. When actuated by the pilot in flight, the nullable rake allowed the transducer zero shifts to be determined and then subsequently removed during data reduction. Design details, the fabrication technique, the principle of operation, brief descriptions of associated digital zero-correction programs and the qualification tests, and test results are included. Sample flight data show that the zero shifts were large and unpredictable but could be measured in flight with the rake. The rake functioned reliably and as expected during 25 hours of operation under flight environmental conditions and temperatures from 230 K (-46 F) to greater than 430 K (314 F). The rake was nulled approximately 1000 times. The in-flight zero-shift measurement technique, as well as the rake design, was successful and should be useful in future applications, particularly where accurate measurements of both steady-state and dynamic pressures are required under adverse environmental conditions. Author

N73-16274# ARO, Inc., Arnold Air Force Station, Tenn.
SIMULATION OF A HIGH DISC LOADING FREE PROPELLER IN A CROSS FLOW BY THE VORTEX-LATTICE METHOD
 Final Report, 10 Nov. 1969 - 30 Jun. 1971
 R. L. Parker, Jr. and F. L. Heltsley AEDC Nov. 1972 102 p refs
 (Contract F40600-73-C-0004; AF Proj. 69BT; ARO Proj. 8D5026)
 (AD-751463; ARO-OMD-TR-72-98; AEDC-TR-72-139) Avail: NTIS CSCL 01/3

A study was conducted to develop an analytical model for the investigation of flow fields about intermediate disc loading lift devices for VTOL applications. Classical vortex-lattice theory was used in conjunction with experimental data for representing a free propeller in a crossflow. The jet phenomena to be simulated by the method are discussed. A number of previous attempts at vortex-lattice modeling are presented. Analytical stream lines and field vectors are compared with available experimental data. The results are evaluated and recommendations are made for further model development. Author (GRA)

N73-16283# Douglas Aircraft Co., Inc., Long Beach, Calif.
A NEW FAMILY OF AIRFOILS BASED ON THE JET-FLAP PRINCIPLE Technical Report, Apr. 1971 - Apr. 1972
 Andrew B. Bauer Sep. 1972 63 p refs
 (Contract N00014-71-C-0250; NR Proj. 215-189)
 (AD-751075; MDC-J5713) Avail: NTIS CSCL 20/4

A new family of airfoils is based largely on the utilization of the jet flap principle and termed power profiles. Several unique features associated with this new concept, and the applicability of existing experimental data and theoretical methods to its evaluation, design and development are described. This technology is used to develop a configuration suitable for wind tunnel testing, and the report concludes with a discussion of some outstanding aerodynamic problems for which analytical and experimental research is required. GRA

N73-16466# Institute for Defense Analyses, Arlington, Va. Jason Div.
STRATOSPHERIC NITRIC OXIDE PRODUCTION FROM PAST NUCLEAR EXPLOSIONS AND ITS RELEVANCE TO PROJECTED SST POLLUTION
 H. M. Foley and M. A. Ruderman Aug. 1972 34 p refs
 (AD-751295; P-894; IDA/HQ-72-14452) Avail: NTIS CSCL 04/1

It is shown that during certain years of intense nuclear testing, high-yield nuclear explosions seem to have injected into the stratosphere a few times 10 to the 34th power nitric oxide molecules. This is very similar to upper estimates for NO generation from 500 SSTs flying for a year. Large catalytic ozone reduction from such NO injection was not observed in worldwide or local total ozone measurements. Author (GRA)

N73-16483* National Aeronautics and Space Administration, Washington, D.C.
SYSTEM FOR INDICATING DIRECTION OF INTRUDER AIRCRAFT Patent

Anne W. Story, inventor (to NASA) Issued 2 Jan. 1973 8 p
 Filed 16 Mar. 1971 Continuation-in-part of abandoned US Patent Appl. SN-808822, filed 20 Mar. 1969
 (NASA-Case-ERC-10226-1; US-Patent-3,708,671;
 US-Patent-Appl-SN-124909; US-Patent-Class-250-209;
 US-Patent-Class-250-215; US-Patent-Class-250-217;
 US-Patent-Class-315-153; US-Patent-Class-340-25;
 US-Patent-Class-340-27R; US-Patent-Appl-SN-808822) Avail: US Patent Office CSCL 14B

A pilot warning indicator system consisting of a flashing beacon, a detector, and an indicating panel is described. The detector responds to radiant energy from another aircraft's beacon by energizing particular signal lamps positioned in the periphery of the pilot's normal field of view. Since the positions of the energized lamps are related to the direction from which radiant energy is received by the detector, the pilot is apprised of the relative position of an intruder aircraft without any shift in visual fixation. Official Gazette of the U.S. Patent Office

N73-16514# Army Aviation Systems Test Activity, Edwards, AFB, Calif.

A PORTABLE INSTRUMENTATION KIT FEASIBILITY STUDY
 Report for 22 May 1970 - Nov. 1971

Robert P. Jefferis and William T. Rivers Jun. 1972 46 p refs
 (USAAVSCOM Proj. 70-17)
 (AD-751188; USAASTA-70-17) Avail: NTIS CSCL 14/2

The purpose of this study was to investigate the feasibility of developing an airborne instrumentation kit that could be easily transported and quickly installed. The system would need to be compatible with anticipated US Army vehicle and test requirements. Results show that a system can be developed which will meet the requirements for all but the most extensive testing. The system will also interface with existing instrumentation and data processing systems. The weight of the system is estimated to be 30 pounds with dimensions of 12 by 15 by 9 inches. The cost is expected to be approximately \$90,000.

Author (GRA)

N73-16524*# Pratt and Whitney Aircraft, East Hartford, Conn.
LABYRINTH SEAL TESTING FOR LIFT FAN ENGINES

L. J. Dobek Feb. 1973 78 p refs

(Contract NAS3-14409)

(NASA-CR-121131; PWA-TM-4593) Avail: NTIS HC \$6.00 CSCL 11A

An abradable buffered labyrinth seal for the control of turbine gas path leakage in a tri-turbine driven lift fan was designed, tested, and analyzed. The seal configuration was not designed to operate in any specific location but was sized to be evaluated in an existing test rig. The final sealing diameter selected was 28 inches. Results of testing indicate that the flow equations predicted seal air flows consistent with measured values. Excellent sealing characteristics of the abradable coating on the stator land were demonstrated when a substantial seal penetration of .030 inch into the land surface was encountered without appreciable wear on the labyrinth knife edges. Author

N73-16576*# Scientific Translation Service, Santa Barbara, Calif.
USE OF COMPOSITE MATERIALS IN AIRCRAFT STRUCTURES

A. S. Volmir, V. F. Pavlenko, and A. T. Ponomarev Washington
 NASA Jan. 1973 17 p refs Transl. into ENGLISH from Mekhan. Polimerov, Akad. Nauk Latv. SSR (Riga), Jan. - Feb. 1972 p 105-112

(Contract NASw-2483)

(NASA-TT-F-14648) Avail: NTIS HC \$3.00 CSCL 11D

The applicability of a group of composite boron and carbon plastic fiber materials in aircraft structural component and engine designs is evaluated as an approach to the damping of aircraft reactions to dynamic and impact forces. The properties of some well-developed composites are compared with those of conventional materials. Examples are given for some aircraft applications of composites. Author

N73-16597 National Lending Library for Science and Technology, Boston Spa (England).

[VISIBILITY MEASUREMENTS FROM THE GROUND AND AN AERODROME]

[1972] 64 p refs Transl. into ENGLISH from Met. Nat. (Paris), no. 76

(NLL-M-20785-(5828.4F)) Avail: Natl. Lending Library, Boston Spa, Engl.: 6 NLL photocopy coupons

Articles on the observation, measurement, and the automatic calculation of runway visibility are presented.

N73-16598 National Lending Library for Science and Technology, Boston Spa (England).

OBSERVATION AND MEASUREMENT OF VISIBILITY AT THE GROUND

C. PerrinDeBrihambaut In its Visibility Measurements from the Ground and an Aerodrome [1972] p 2-38

The determination of visibility on an airport is discussed. Definitions of daylight and night visibilities, meteorological optical range, runway visual range, quantities and fundamental units are presented. Visibility measuring instruments which depend on measuring the opacity of the atmosphere, or the mean coefficient of extinction discussed include telephotometric instruments, extinction instruments, and photoelectric transmission instruments. The orientation and calibration of equipment is discussed along with the standardization of measuring procedures. F.O.S.

N73-16599 National Lending Library for Science and Technology, Boston Spa (England).

AUTOMATIC CALCULATION OF RUNWAY VISUAL RANGE ON AN AERODROME

A. Bettan *In its* Visibility Measurements from the Ground and an Aerodrome [1972] p 39-61

The use of a LYNX controlled transmissometer is discussed for rapid measurement and continuous dissemination of visibility to aircraft on final approach, or takeoff. The general principles used to calculate horizontal visibilities are reviewed, and the collection and dissemination of visibilities by the transmissometer are described along with the LYNX computer programming. F.O.S.

N73-16612# Transportation Systems Center, Cambridge, Mass. **CLIMATIC IMPACT ASSESSMENT PROGRAM. PROCEEDINGS OF THE SURVEY CONFERENCE**

A. E. Barrington Sep. 1972 289 p refs Conf. held at Cambridge, Mass.; 15-16 Feb. 1972

(Contract DOT-OS-320)

(PB-212427; DOT-TSC-OST-72-13) Avail: NTIS HC \$3.00 CSCL 04A

The report contains the proceedings of a survey conference, concerning the impact of climatic changes which might result from perturbation of the upper atmosphere by the exhaust effluent of a world high altitude aircraft fleet, as projected to 1990. The reports deal with the general categories of engine emissions, the natural stratospheric perturbations, and risk/benefit analysis. All but one of the talks are included in the volume, each followed by an abbreviated version of the ensuing open discussion. GRA

N73-16628# Cornell Aeronautical Lab., Inc., Buffalo, N.Y. **INVESTIGATIONS OF MLS CONVENTIONAL AND DOPPLER SCANNING BEAM TECHNIQUES** Final Report, Jun. 1971 - Sep. 1972

J. Beneke, C. W. Wightman, H. D. Becker, and C. E. Kassel Sep. 1972 182 p refs

(Contract DOT-FA71WA-2592)

(AG-5011-B-1; FAA-RD-72-124) Avail: NTIS HC \$11.25

The results of analytical and experimental investigations carried out in support of the Microwave Landing System (MLS) program of the Federal Aviation Administration are summarized. The experimental program consisted of a simulation of the MLS signals that would be received in an aircraft. The systems simulated included conventional scanning beams with frequency and pulse angle coding, step-scan beams with frequency and time interval coding and the Doppler scan technique. Angle measurement errors were determined for a wide range of signal parameters. Errors were measured in the presence of a single multipath of variable characteristics. Conclusions were drawn concerning the capability of the several signal formats to meet certain accuracy requirements. The need for special processing techniques to reduce the effects of multipath is discussed. Author

N73-16629# IIT Research Inst., Annapolis, Md. **AIR TRAFFIC CONTROL SYSTEMS INTERFERENCE CONSIDERATIONS** Final Report

F. Tabor and J. Shields Mar. 1972 53 p refs

(Contract DOT-FA70WAI-175; FAA Proj. 213-516-035)

(ECAC-PR-72-008; FAA-RD-72-20) Avail: NTIS HC \$4.75

The FAA Air Traffic Control Navigation/Communications system is examined to identify areas within the system that are particularly susceptible to radio frequency interference effects. The identified areas are investigated in the light of known past and present analyses, and recommendations for further studies

are made. The report concludes that the cosite aspects of the FAA VHF communications system requires further study in order to derive a practical means for achieving electromagnetic compatibility in the future. Author

N73-16630# IIT Research Inst., Annapolis, Md. **ATCRBS PERFORMANCE ANALYSIS FOR NEW YORK AIR ROUTE TRAFFIC CONTROL CENTER** Final Report

Charles A. Gettier Jul. 1972 47 p refs

(Contract DOT-FA70WAI-175; FAA Proj. 213-503-015)

(ECAC-PR-72-031; FAA-RD-72-35) Avail: NTIS HC \$4.50

The occurrence of excessive interrogation signals (hot spots) within air traffic control sectors supervised by the Air Traffic Control Beacon System (ATCRBS) of the Federal Aviation Administration is evaluated. On-site observations of air traffic displays are discussed, and the analyses of the air traffic electromagnetic environments using performance prediction model techniques are described. Each of the studies evaluates the possibility of hot spots affecting one of the following ATCRBS Air Route Traffic Control Centers: Jacksonville, Washington, New York, Kansas City, and Los Angeles. Author

N73-16632# German Air Traffic Controller's Association, Langenhagen (West Germany).

AIR TRAFFIC CONTROL PROBLEMS FROM THE CONTROLLER'S POINT OF VIEW [FLUGSICHERUNGSPROBLEME AUS DER SICHT DER FLUGLOTSEN]

Wolfgang Kassebohm 1972 7 p In GERMAN Presented at the DGLB Symp. on Flugbetrieb, Cologne, 15 Sep. 1972

(DGLR-Paper-72-038) Avail: NTIS HC \$3.00

The problems of air traffic control due to the increasing volume of air traffic are discussed. A solution is suggested which consists of a basic reform of air traffic law, and a central government authority responsible for all safety regulations. Author (ESRO)

N73-16634# Mitre Corp., Bedford, Mass. **UNDERSTANDING KALMAN FILTERING AND ITS APPLICATION IN REAL TIME TRACKING SYSTEMS**

J. J. Burke Jul. 1972 70 p refs

(Contract F19628-71-C-0002; AF Proj. 4510)

(AD-751485; MTR-2417; ESD-TR-72-312) Avail: NTIS CSCL 17/7

The theory and applications of Kalman filtering have now been under development for over a decade. Kalman filtering is currently being used operationally in numerous applications such as satellite tracking systems, aircraft navigational systems and aircraft tracking systems. Because Kalman filtering is a statistical concept that is typically described in terms of state-space notation, project managers and engineers must frequently accept an abstract set of equations while feeling insufficiently qualified to appreciate their significance or applicability. In spite of the obscure terminology and associated matrix notation that typically accompanies any discussion of Kalman filtering, the salient features of the theory are relatively straightforward and can be presented in a manner that appeals to intuition. The paper represents such an attempt with emphasis on applications to real time tracking systems. Author (GRA)

N73-16635# Human Factors Research, Inc., Santa Barbara, Calif.

THE LANDING SIGNAL OFFICER: DISPLAY REQUIREMENTS FOR ACLS RECOVERIES Final Technical Report

Albert Harabedian, Gail J. Borden, and Gene R. Kelley Sep. 1972 85 p refs

(Contract N00014-71-C-0258; NR Proj. 215-190)

(AD-751076; Rept-1720-F) Avail: NTIS CSCL 17/7

A description of a study to determine the information displays required by LSOs to effectively control aircraft in the Automatic Carrier Landing System environment is presented. Dangerous and safe approaches were flown in an F-4B aircraft simulator. Displays of selected information about the aircraft's performance during the approaches were produced with a computer and recorded on motion picture film. The information

displays were integrated Glide-Slope and Line-Up deviations. Range, Airspeed, Power, Angle of Attack, and Sink-Rate. Groups of LSOs viewed the different display combinations. The LSO's task was to wave-off the aircraft if he judged the approach to be dangerous.

Author

N73-16651# Ultrasytems, Inc., Newport Beach, Calif.
THE EFFECTS OF LOCAL METEOROLOGICAL FACTORS UPON AIRCRAFT NOISE MEASUREMENTS Final Report, Aug. - Nov. 1972

D. C. Wooten and R. L. Eidemiller 12 Nov. 1972 47 p refs
 (Contract DOT-FA73WI-0382-1)
 (FAA-RD-72-145) Avail: NTIS HC \$4.50

Aircraft noise measurements from the Boeing 737, made at Orange County Airport, Santa Ana, California, during operational conditions, are statistically correlated with the local meteorological factors including wind force and direction, temperature, humidity, barometric pressure, ceiling and visibility. The correlation was carried out using regression techniques and indicated that there is a significant inverse correlation between temperature and noise level. Wind speed appeared to be of significance in one calculation that included wind speeds up to 25 knots, but was not significant when the range of wind speeds was 15 knots and below.

Author

N73-16654*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

NEW ASPECTS OF SUBSONIC AERODYNAMIC NOISE THEORY

Marvin E. Goldstein and Walton L. Howes Washington Feb. 1973 40 p refs

(NASA-TN-D-7158; E-7047) Avail: NTIS HC \$3.00 CSCL 20A

A theory of aerodynamic noise is presented which differs from Lighthill's theory primarily in the way in which convection of the noise sources is treated. The sound directivity pattern obtained from the present theory agrees better with jet-noise directivity data than does that obtained from Lighthill's theory. The results imply that the shear-noise contribution to jet noise is smaller than previously expected.

Author

N73-16655*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THE EFFECT OF NOZZLE INLET SHAPE, LIP THICKNESS, AND EXIT SHAPE AND SIZE ON SUBSONIC JET NOISE

W. A. Olsen, O. A. Gutierrez, and R. G. Dorsch 1973 28 p refs Presented at 11th Aerospace Sci. Meeting, Washington, D. C., 10-12 Jan. 1973; sponsored by Am. Inst. of Aeron. and Astronaut.

(NASA-TM-X-68182; E-7289) Avail: NTIS HC \$3.50 CSCL 20A

Far field noise data were taken for convergent nozzles of various shapes and sizes at subsonic velocities exceeding 400 feet per second. For a circular nozzle, the nozzle inlet shape and lip thickness had no effect on the noise level, directivity, or spectra when compared at the same nozzle exit diameter and peak exhaust velocity. A sharp edged orifice was one exception to this statement. Coannular nozzles can produce additional high frequency noise. Blunt ended centerbodies, where there is significant base drag, also generate significant additional noise. The total noise power generation was essentially the same for circular, slot, and plug nozzles of good aerodynamic shape. The noise radiation patterns were essentially the same for these nozzle shapes except near the nozzle exhaust axis.

Author

N73-16658# Institut Franco-Allemand de Recherches, St. Louis (France).

STUDY OF THE SENSITIVITY OF NITROGLYCERIN TO WEAK SHOCK WAVES (SUPERSONIC AIRCRAFT BANGS) (UNTERSUCHUNG DER EMPFINDLICHKEIT VON NITROGLYCERIN GEGEN SCHWACHE STOSSWELLEN (FLUGZ-EUGKNALL))

H. W. Koch, I. Bischoff, and L. Philipp 27 Apr. 1972 19 p refs In GERMAN

(ISL-14/72) Avail: NTIS HC \$3.00

The resistance of nitroglycerin to weak shock waves corresponding to the sonic boom caused by aircraft was examined. Tests were carried out in a sonic boom generator which produced shock waves with pressure gradients up to 50 mbar and a duration of 345 ms in order to investigate detonation risk under the sonic boom effect. Nitroglycerin samples in layers 6 mm thick, placed in a bowl covered with a thin plastic layer, were exposed to incident frontal waves. No detonation was observed either during these tests or during the same tests carried out with other primers.

ESRO

N73-16748# Honeywell, Inc., Bloomington, Minn. Corporate Research Center.

PROPERTIES AND LIMITATIONS OF LIQUID CRYSTALS FOR AIRCRAFT DISPLAYS Final Technical Report, 1 Feb. 1971 - 30 May 1972

Ulrich Bonne and John P. Cummings Oct. 1972 185 p refs
 (Contract N00014-71-C-0262; NR Proj: 215-173)

(AD-751667; HR-72-285:4-35) Avail: NTIS CSCL 07/4

The objectives of the study were to determine the feasibility of using nematic liquid crystals as media for aircraft displays from the viewpoint of their temperature range, response time, grey scale and color control. These parameters were determined experimentally for various liquid crystal systems (pure compounds as well as mixtures), at various temperatures and under various operating conditions (AC and DC drive voltage, cell thickness, reflective and transmissive modes). Mathematical modeling of the temperature range achievable through formation of multiple eutectic mixtures, of response times (delay rise, and fall times), of the voltage dependent brightness of reflective and transmissive displays, and of the properties of LC color displays via the forced alignment technique matched the experimental data and was used to define the conditions (material, cell construction, and operating parameters) under which a temperature range of -54 to 71°C, a 1 microsecond response time, a 10-step grey scale (in steps of 2 in conjunction with a display brightness and a viewing angle range close to those accepted for paper-and-ink displays) and a full color display can be achieved.

Author (GRA)

N73-16758# Lincoln Lab., Mass. Inst. of Tech., Lexington.
ADVANCED ELECTRONIC TECHNOLOGY Quarterly Technical Summary, 1 May - 31 Jul. 1972

Melvin A. Herlin, Herbert G. Weiss, and Alan L. McWhorter 15 Aug. 1972 30 p refs

(Contract F19628-73-C-0002; AF Proj. 649L)
 (AD-751308; ESD-TR-72-210) Avail: NTIS CSCL 20/12

Contents: Integrated circuit processing; Photolithographic interconnection of plastic-embedded semiconductor chips; Testing and mask design; Applications and circuit design; Communications, navigation, and identification (CNI) studies; Approach and landing systems; Airborne traffic situation display (ATSD); Solid state device research; Quantum electronics; Materials research; Physics of solids; Microelectronics.

GRA

N73-16771*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

COMPARISON OF COMBUSTION CHARACTERISTICS OF ASTM A-1, PROPANE, AND NATURAL-GAS FUELS IN AN ANNULAR TURBOJET COMBUSTOR

Jerrold D. Wear and Robert E. Jones Washington Jan. 1973 23 p refs

(NASA-TN-D-7135; E-7078) Avail: NTIS HC \$3.00 CSCL 21D

The performance of an annular turbojet combustor using natural-gas fuel is compared with that obtained using ASTM A-1 and propane fuels. Propane gas was used to simulate operation with vaporized kerosene fuels. The results obtained at severe operating conditions and altitude reight conditions show that natural gas is inferior to both ASTM A-1 and propane fuels. Combustion efficiencies were significantly lower and combustor pressures for reight were higher with natural-gas fuel than with the other fuels. The inferior performance of natural gas is shown to be caused by the chemical stability of the methane molecule.

Author

N73-16772# National Aviation Facilities Experimental Center, Atlantic City, N.J.

THE FEASIBILITY OF BURNER-CAN BURN-THROUGH THERMAL DETECTION PRIOR TO ENGINE CASE RUPTURE

Final Report, Jan. - Sep. 1972

Richard Hill Jan. 1973 36 p ref

(FAA Proj. 181-522-01X)

(FAA-NA-72-92; FAA-RD-72-134) Avail: NTIS HC \$4.00

Full-scale tests simulating engine combustion section thermal failures (burn-through) were conducted using a J57 engine (cowed and uncowed) to determine the feasibility of detecting a burn-through prior to its occurrence by monitoring engine skin temperature. Results of the tests indicated that as few as four thermocouples, located 90 degrees apart around the diffuser case and/or burner can case, could detect a burn-through prior to engine case rupture. Author

N73-16773# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL PERFORMANCE OF CASCADE THRUST REVERSERS AT FORWARD VELOCITY

Donald A. Dietrich and Roger W. Luidens Washington 1973 22 p refs

(NASA-TM-X-2665; E-7125) Avail: NTIS HC \$3.00 CSCL 21E

A series of static and wind tunnel tests were performed on four cowl cascade thrust reverser configurations which had various reversed jet emission patterns applicable to an externally blown flap STOL aircraft. The work was performed using a model fan which was 14.0 cm in diameter and passed a fan mass flow of 2.49 kg/sec at an approximate fan pressure ratio of 1.22 and fan corrected rotational speed of 35,800 rpm. The tests demonstrated that the reingestion of fan flow significantly reduced the reverser efficiency and that the thrust reverser efficiency was improved by reducing the reversed jet azimuthal emission angle. The reverser efficiency at STOL landing speeds was as high as 0.95; however, configurations with lateral emission were adversely affected by yawing the nacelle at forward velocity. Measurements of the internal static pressure at the stator exit showed significant increases in the local static pressure for configurations with reduced jet emission angles. Author

N73-16776# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EFFECT OF A REDUCTION IN BLADE THICKNESS ON PERFORMANCE OF A SINGLE STAGE 20.32 CENTIMETER MEAN DIAMETER TURBINE

William J. Nusbaum and Milton G. Kofskey Washington Feb. 1973 26 p refs

(NASA-TN-D-7128; E-7029) Avail: NTIS HC \$3.00 CSCL 21E

As part of a program to reduce the manufacturing costs of a small gas-turbine engine, the turbine blading was reduced in thickness to facilitate coining. Tests were made to determine the effect of this modification on turbine performance. The working fluid was air at nominal inlet total conditions of 535 deg F and 20.0 psia. Performance results are presented and compared for four stator-rotor combinations in terms of equivalent torque, mass flow, and efficiency at equivalent design speed and at inlet-total to exit-static pressure ratios of 1.8 to 3.8. Author

N73-16778# General Electric Co., Cincinnati, Ohio.

HIGHLY LOADED MULTI-STAGE FAN DRIVE TURBINE-CASCADE TEST PROGRAM

D. G. Cherry, T. K. Staley, and M. W. Thomas Washington NASA Jan. 1973 153 p refs

(Contract NAS3-14304)

(NASA-CR-2171; Rept-72AEG268) Avail: NTIS HC \$3.00 CSCL 21E

Test results are presented for 19 cascades involving five plain and two tandem blade sections. High camber and/or negative reaction is associated with six of the sections. Exit Mach numbers range up to slightly above sonic. Cascade efficiency, exit flow

angle and static pressure, and blade surface pressure data are reported with incidence angle, Mach number, solidity, and relative position of the tandem blades as independent variables. Author

N73-16781# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio. Ramjet Applications Branch.

SUBSONIC PERFORMANCE POTENTIAL OF RAMJETS AND EJECTOR RAMJETS Technical Report, Dec. 1970 - Sep. 1971

William E. Supp, John H. Miller, and Kenneth A. Watson May 1972 99 p refs

(AF Proj. 3012)

(AD-751317; AFAPL-TR-72-7) Avail: NTIS CSCL 21/5

A method for analyzing the performance of a ramjet engine at subsonic flight speeds is presented. The absence of a known choked point ($M=1$) in the engine necessitates an iterative solution. A modified ideal gas analysis is utilized. Considered are the conventional ramjet with liquid fuel injection and an ejector ramjet using vaporized fuel injected into the engine at supersonic velocities. In the latter case, the fuel's momentum is significant and the ejector action draws additional air mass into the engine, which must be considered in the analysis. The method presented compares the two engine cycles at several subsonic flight speeds for both JP-4 and propane fuel. The effects of several levels of component efficiencies are considered.

Author (GRA)

N73-16783# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DESIGN PRINCIPLES OF AIRCRAFT ENGINES, CHAPTERS 1-5

E. L. Feldman, G. I. Danileiko, and L. N. Kapustin 6 Jul. 1972 192 p Transl. into ENGLISH of the publ. "Osnovy Konstruktsii Aviatsonnykh Dvigatelyey" Moscow, Izd-vo Transport, 1970 p 1-123

(AD-751510; FTD-MT-24-1903-71) Avail: NTIS CSCL 21/5

In the book, general questions of design of gas-turbine engines (with mention of piston engines) are presented, their design diagrams are analyzed, the purpose, arrangement, and service conditions of units, assemblies and systems are described, as well as the loads experienced by them and also the materials used, the requirements imposed on structural elements and systems, and the simplest structural designs are set forth. The book is intended as a text for students in technical schools and schools of civil aviation. It can be used by technical-engineering and flight crews of civil aviation. Author (GRA)

N73-16784# Rohr Corp., Chula Vista, Calif.

ANALYTICAL STUDY OF INFLIGHT THRUST REVERSERS, VOLUME 1 Final Technical Report, 25 Jan. 1971 - 25 May 1972

Tirumalesa Duvvuri, Hai-Yain Chang, and Barry W. Prior Jul. 1972 353 p refs

(Contract F33615-71-C-1208; AF Proj. 1478)

(AD-751525; RHR-72-365-1; AFFDL-TR-72-85-Vol-1) Avail: NTIS CSCL 21/5

Mathematical models are developed for predicting the flow fields within and external to a thrust reverser when it is deployed in flight, and the forces and moments induced on the aircraft by virtue of these flow fields. The method used are largely two-dimensional in nature, but contain empirical corrections to account for three-dimensionality. Although no testing was accomplished under this contract, the analytical predictions are compared with existing test data. A method of evaluating stowed reverser losses is given, twin-jet and unsteady flow effects are discussed and a test/analytical program is outlined which is aimed at further improving and verifying the results of the study. This volume contains the technical discussion and results of the analytical effort. Author (GRA)

N73-16785# Rohr Corp., Chula Vista, Calif.

ANALYTICAL STUDY OF INFLIGHT THRUST REVERSERS, VOLUME 2: USER'S MANUAL AND SOURCE LISTINGS

FOR COMPUTER PROGRAMS

Tirumalesa Duvvuri, Hai-Yain Chang, Barry W. Prior, and Miriam J. Alcala Jul. 1972 235 p refs
(Contract F33615-71-C-1208; AF Proj. 1478)
(AD-751526; RHR-72-365-2; AFFDL-TR-72-85-Vol-2) Avail:
NTIS CSCL 21/5

Fifteen computer programs have been developed to solve problems for the analytical study of inflight thrust reversers. User instructions for all 15 programs are presented in this Volume, including a brief theoretical background, the function, input and output of each program. Lists of sample input and output are also included. Listings of all computer programs are included in the Appendix. The detailed descriptions of all theoretical developments are given in Volume I of the report.

Author (GRA)

N73-16896# Advisory Group for Aerospace Research and Development, Paris (France).

SYMPOSIUM ON RANDOM LOAD FATIGUE

Oct. 1972 237 p refs Symp. held at 34th meeting of the AGARD Struct. and Mater. Panel, Lyngby, Denmark, 13 Apr. 1972; sponsored by Struct. and Mater. Panel
(AGARD-CP-118) Avail: NTIS HC \$14.00

Physical aspects of fatigue damage accumulation and the significance of theories for the calculation of fatigue damage accumulation are reviewed. Influence of test frequencies on crack propagation rates, measurements of residual stresses in notched specimens, etc. are reported.

N73-16897 Societe Nationale Industrielle Aerospatiale, Paris (France).

A SHORT SURVEY ON POSSIBILITIES OF FATIGUE LIFE ASSESSMENT OF AIRCRAFT STRUCTURES BASED ON RANDOM OR PROGRAMMED FATIGUE TESTS

W. Barrois /in AGARD Symp. on Random Load Fatigue Oct. 1972 21 p refs

After considering designers' needs and detailing the various physical parameters that are significant in the fatigue behavior of specimens and structures, several types of fatigue tests are reviewed. Prediction methods of structure fatigue life from fatigue tests of components, assemblies and structures undergoing constant amplitude loadings are surveyed. After considering fatigue tests under programmed loadings, the case of random loadings is briefly discussed. It is concluded that describing random loadings by their root mean squares is not sufficient to predict the fatigue lives of structures even when the shape of the load power spectrum is known, except in cases of comparative prediction where the only change is the general intensity of the spectrum. The possibility of test acceleration by increasing the general loading intensity is considered. Author

N73-16898 Royal Aircraft Establishment, Farnborough (England). Structures Dept.

SOME EFFECTS OF CHANGE IN SPECTRUM SEVERITY AND SPECTRUM SHAPE ON FATIGUE BEHAVIOUR UNDER RANDOM LOADING

W. T. Kirkby /in AGARD Symp. on Random Load Fatigue Oct. 1972 19 p refs

The problem of reassessing the fatigue life of an aircraft structure is considered, when it is found that the spectrum of loads experienced in service differs from the load spectrum applied in test. Results obtained during fatigue tests on structural elements under random load spectra are used to illustrate some of the important considerations involved. It is shown that the use of an improved method of life prediction will generally lead to improved accuracy in reassessing life. Author

N73-16899 National Aerospace Lab., Amsterdam (Netherlands). **THE ACCUMULATION OF FATIGUE DAMAGE IN AIRCRAFT MATERIALS AND STRUCTURES**

J. Schijve /in AGARD Symp. on Random Load Fatigue Oct. 1972 120 p refs

Physical aspects of fatigue damage accumulation are discussed, including interaction and sequence effects. Empirical trends observed in variable-amplitude tests are summarized including the effects of a high preload, periodical high loads, ground-to-air cycles, and the variables pertaining to program loading, random loading, and flight simulation loading. This also includes results from full scale fatigue test series. Various theories on fatigue damage accumulation are recapitulated. The significance of these theories for explaining empirical trends as well as for estimating fatigue properties as a design problem is evaluated. Author

N73-16900 National Aerospace Lab., Amsterdam (Netherlands). **EFFECTS OF TEST FREQUENCY ON FATIGUE CRACK PROPAGATION UNDER FLIGHT-SIMULATION LOADING**

J. Schijve /in AGARD Symp. on Random Load Fatigue Oct. 1972 17 p refs

Fatigue crack propagation in 2024-T3 and 7075-T6 sheet material was studied at three test frequencies, viz. 10, 1, and 0.1 cycles per second. The flight simulation loading was based on a gust spectrum. The design stress level was adopted as a second variable. Differences between the crack propagation rates at the three test frequencies were small and unsystematic. The propagation was much slower than predicted from constant amplitude test data. Moreover, the macro-cracking behavior appeared to be different. Author

N73-16901 Air Force Systems Command, Wright-Patterson AFB, Ohio.

CORRELATION BETWEEN LABORATORY TESTS AND SERVICE EXPERIENCE

W. B. Miller and Holland B. Lowndes /in AGARD Symp. on Random Load Fatigue Oct. 1972 16 p refs

Direct comparisons are made between full scale fatigue test failures and actual service failures for several military aircraft. The correlations are discussed in relation to the basic fatigue test procedures and spectra used. Some methods used to force correlation where apparent correlation is lacking are discussed. The improvements in fatigue testing evolved over the past 25 years are summarized. Author

N73-16902 Technical Univ. of Denmark, Lyngby. Dept. of Solid Mechanics.

ON RESIDUAL STRESSES DURING RANDOM LOAD FATIGUE

Find Rotvel /in AGARD Symp. on Random Load Fatigue Oct. 1972 14 p refs

Data are presented from random fatigue tests on normalized carbon steel with 0.7% carbon. In notched specimens, a preload beyond the yield stress induced residual stresses around the notch. The residual stresses were measured with an X-ray measuring technique at intervals during the fatigue loading. Results from broadband and narrowband stochastic loading tests are compared with constant amplitude sinusoidal tests. Author

N73-16903 Industrieanlagen-Betriebsgesellschaft m.b.H., Otto-brunn (West Germany).

THE FATIGUE LIFE UNDER THREE DIFFERENT LOAD SPECTRA - TESTS AND CALCULATIONS

Walter Schuetz /in AGARD Symp. on Random Load Fatigue Oct. 1972 10 p refs

One of the more important problems in the fatigue life prediction of military airplanes is caused by the difference between the load spectrum used in the full scale fatigue test and the load spectrum in service. Complex flight-by-flight tests with two types of notched specimens and a bolted joint simulating a skin fitting joint were carried out under three different load spectra occurring in service of a German military airplane. It is shown that Miner's rule can be used as a transfer function (relative Miner rule) to calculate the lives with high accuracy for the notched specimens and with less accuracy for the bolted specimens. Author

N73-16904 Laboratorium fuer Betriebsfestigkeit, Darmstadt (West Germany).

A RELATION BETWEEN MEASURED CENTER OF GRAVITY VERTICAL ACCELERATIONS AND THE LOADS AT THE T-TAIL OF A MILITARY AIRPLANE c02

Otto Buxbaum In AGARD Symp. on Random Load Fatigue Oct. 1972 16 p refs

An engineering solution is presented for correlating two different random loads - time histories, based on measurements of C.G. vertical accelerations and loads at the tailplane of an aircraft. The choice of instrumentation for a fleet airplane is described, and the measurements of operational loads are related to C.G. acceleration countings. Author

N73-16905* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

EVALUATION OF AN AEROELASTIC MODEL TECHNIQUE FOR PREDICTING AIRPLANE BUFFET LOADS

Perry W. Hanson Washington Feb. 1973 62 p refs

(NASA-TN-D-7066; L-8460) Avail: NTIS HC \$3.00 CSCL 01C

A wind-tunnel technique which makes use of a dynamically scaled aeroelastic model to predict full-scale airplane buffet loads during buffet boundary penetration is evaluated. A 1/8-scale flutter model of a fighter airplane with remotely controllable variable-sweep wings and trimming surfaces was used for the evaluation. The model was flown on a cable-mount system which permitted high lift forces comparable to those in maneuvering flight. Bending moments and accelerations due to buffet were measured on the flutter model and compared with those measured on the full-scale airplane in an independent flight buffet research study. It is concluded that the technique can provide valuable information on airplane buffet load characteristics not available from any other source except flight test. Author

N73-16929* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

HIGH-PRESSURE COMBUSTOR EXHAUST EMISSIONS WITH IMPROVED AIR-ATOMIZING AND CONVENTIONAL PRESSURE-ATOMIZING FUEL NOZZLES

Robert D. Ingebo and Carl T. Norgren Washington Feb. 1973 24 p refs

(NASA-TN-D-7154; E-7148) Avail: NTIS HC \$3.00 CSCL 21B

A high-pressure combustor segment 0.456 meter (18 in.) long with a maximum cross section of 0.153 by 0.305 meter (6 by 12 in.) was tested with specially designed air-atomizing and conventional pressure-atomizing fuel nozzles at inlet-air temperatures of 340 to 755 K (610 deg to 1360 R), reference velocities of 12.4 to 26.1 meters per second (41 to 86 ft/sec), and fuel-air ratios of 0.008 to 0.020. Increasing inlet-air pressure from 4 to 20 atmospheres generally increased smoke number and nitric oxide, but decreased carbon monoxide and unburned hydrocarbon concentrations with air-atomizing and pressure-atomizing nozzles. Emission indexes for carbon monoxide and unburned hydrocarbons were lower at 4, 10, and 20 atmospheres, and nitric oxide emission indexes were lower at 10 and 20 atmospheres with air-atomizing than with pressure-atomizing nozzles. Author

N73-16943* Aeronautical Research Labs., Melbourne (Australia). [AERONAUTICAL RESEARCH AND DEVELOPMENT] Annual Report, 1971 - 1972

1972 90 p refs Original contains color illustrations Avail: NTIS HC \$6.50

Aeronautical research is reported for 1971-1972. Work in the following areas is discussed: aircraft materials, defect detection, aircraft structures, aerodynamic, propulsion, high temperature, turbine blades, human factors, instrumentation, testing, damage assessment, and life of aircraft engines.

F. O. S.

N73-16978* Parsons-Brinckerhoff-Tudor-Bechtel, San Francisco, Calif.

SAN FRANCISCO AIRPORT ACCESS PROJECT

May 1972 40 p Prepared in cooperation with Smith (Wilbur) and Associates, San Francisco, Calif. and Kirker, Chapman Consultants, San Francisco, Calif.

(Contract DOT-UT-262)

(PB-212456; UMTA-CA-09-0012-72-1) Avail: NTIS HC \$3.00 CSCL 13B

An earlier study of the feasibility of extending the Bay Area Rapid Transit (BART) system to serve San Francisco International Airport is summarized. This summary was prepared to answer several basic questions about the proposed BART extensions: (1) how can such transit help? (2) how soon is it needed? (3) what will it be like? (4) how might the cost be shared? (5) will it be built? A proposed route description and various financing alternatives are discussed. GRA

N73-16981* Aeronautical Research Labs., Melbourne (Australia). **A SIDE MOUNTED SUPERSONIC INTAKE AND THE PROBLEM OF THREE DIMENSIONAL BOUNDARY LAYER SEPARATION**

Murdoch Culley Jun. 1972 49 p refs

(ARL/ME-137; ISBN-642-97744-5) Avail: NTIS HC \$4.50

As part of a program to study integrated supersonic intakes and their associated interference problems, a model has been constructed consisting of a half-conical intake mounted on the side of a fuselage. The flow field around this model has been qualitatively examined using schlieren and surface flow techniques. A strong three dimensional separation of the fuselage boundary layer has been observed; the location of the separation line is sensitive to the condition of the fuselage boundary layer and to the intake static pressure field. As a result of three dimensional flow over the shock cone, the intake has a weaker pressure field than an equivalent axisymmetric intake. Consequently the observed separation occurs under the combined influence of the normal and cone shocks, and thus the location of the separation line is sensitive to the position of the normal shock. The separation gives rise to an unsteady shock wave, and this indicates, despite the finely detailed flow patterns obtained, that the separation is unsteady. This boundary layer shock generates a Mach number gradient and thus modifies the intake shock system. Author

N73-16982* Northrop Corporate Labs., Hawthorne, Calif. **ANALYSIS OF HIGH-ASPECT-RATIO JET-FLAP WINGS OF ARBITRARY GEOMETRY**

Peter B. S. Lissaman Washington NASA Feb. 1973 58 p refs

(Contract NAS1-10627)

(NASA-CR-2179) Avail: NTIS HC \$3.00 CSCL 01A

An analytical technique to compute the performance of an arbitrary jet-flapped wing is developed. The solution technique is based on the method of Maskell and Spence in which the well-known lifting-line approach is coupled with an auxiliary equation providing the extra function needed in jet-flap theory. The present method is generalized to handle straight, uncambered wings of arbitrary planform, twist, and blowing (including unsymmetrical cases). An analytical procedure is developed for continuous variations in the above geometric data with special functions to exactly treat discontinuities in any of the geometric and blowing data. A rational theory for the effect of finite wing thickness is introduced as well as simplified concepts of effective aspect ratio for rapid estimation of performance. Author

N73-16983* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

GENERALIZE AERODYNAMIC COEFFICIENT TABLE STORAGE, CHECKOUT AND INTERPOLATION FOR AIRCRAFT SIMULATION

Frank Neuman and Neil Warner Jan. 1973 107 p

(NASA-TM-X-62229) Avail: NTIS HC \$7.50 CSCL 01A

The set of programs described has been used for rapidly introducing, checking out and very efficiently using aerodynamic tables in complex aircraft simulations on the IBM 360. The

preprocessor program reads in tables with different names and dimensions and stores them on disc storage according to the specified dimensions. The tables are read in from IBM cards in a format which is convenient to reduce the data from the original graphs. During table processing, new auxiliary tables are generated which are required for table cataloging and for efficient interpolation. In addition, DIMENSION statements for the tables as well as READ statements are punched so that they may be used in other programs for readout of the data from disc without chance of programming errors. A quick data checking graphical output for all tables is provided in a separate program. Author

N73-16984# Aeronautical Research Inst. of Sweden, Stockholm. BOUNDARY LAYER STUDIES ON A TWO DIMENSIONAL HIGH LIFT WING

Bjoern L. G. Ljungstrom* 1972 110 p refs
(FAA-AU-862) Avail: NTIS HC \$7.50

Wind tunnel tests were carried out with a 2-dimensional wing model equipped with a leading edge slat and a trailing edge flap. The objectives of the investigation have been the following: (1) to increase general understanding of the viscous and inviscid flow phenomena on a high lift wing and significance to the high lift performance. And (2) to investigate the significance of Reynolds number effects for high lift wings by an attempt to simulate higher Reynolds number boundary layers. The model was equipped with two suction slots at a distance of 30 slot widths from the trailing edges of the leading edge slat and the main wing. The different amounts of suction applied resulted in a reduced boundary layer thickness at the trailing edge of the leading edge slat and the main wing, respectively. The various suction configurations have been tested for two leading edge slat gaps. The pressure distributions and the complete boundary layer velocity profiles have been mapped at a few angles of attack. Author

N73-16985# Aeronautical Research Inst. of Sweden, Stockholm. A COMPUTER PROGRAM FOR THE PREDICTION OF AERODYNAMIC CHARACTERISTICS OF WING-BODY-TAIL COMBINATIONS AT SUBSONIC AND SUPERSONIC SPEEDS, PART 2

S. Anders and L. Gustavsson 1972 120 p refs
(FAA-AU-835-Pr-2) Avail: NTIS HC \$8.00

A computer program for calculating the aerodynamic characteristics of wing-body combinations at subsonic and supersonic speeds is described. The aerodynamic theory is outlined and several calculated examples with comparisons to experimental results are shown. A description of the computer program is provided together with a user's manual. The results indicate that the method is a valuable tool for analysis and design purposes. Author

N73-16986*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYTICAL STUDY ON A TWO-DIMENSIONAL PLANE OF THE OFF-DESIGN FLOW PROPERTIES OF TANDEM-BLADED COMPRESSOR STATORS

Nelson L. Sanger Washington Mar. 1973 43 p refs
(NASA-TM-X-2734; E-7031) Avail: NTIS HC \$3.00 CSCI 20D

The flow characteristics of several tandem bladed compressor stators were analytically evaluated over a range of inlet incidence angles. The ratios of rear-segment to front-segment chord and camber were varied. Results were also compared to the analytical performance of a reference solid blade section. All tandem blade sections exhibited lower calculated losses than the solid stator. But no one geometric configuration exhibited clearly superior characteristics. The front segment accepts the major effect of overall incidence angle change. Rear- to front-segment camber ratios of 4 and greater appeared to be limited by boundary-layer separation from the pressure surface of the rear segment. Author

N73-16987 California Univ., Los Angeles. AERODYNAMIC AND STRUCTURAL DESIGN CONSIDERATIONS FOR HIGH LIFT BIPLANE WING SYSTEMS Ph.D.

Thesis

Robert Briand Addoms 1971 172 p
Avail: Univ. Microfilms Order No. 72-13586

Modern theoretical methods and computer technology are applied to the design of biplane wing systems. Biplane aerodynamics are discussed, with emphasis on the stall matching and induced camber effects which make the biplane different from the monoplane. The theoretical basis of a method for designing biplane airfoils is presented. The method uses three-dimensional potential flow theory, combined with two-dimensional thin airfoil theory. The application of this method to an actual design is described in detail. It is shown that for virtually any biplane configuration of practical interest, it is possible to design a biplane wing system which sacrifices nothing in maximum usable lift coefficient without flaps to monoplanes, and next to nothing with flaps. Such a wing system has approximately half the weight per unit area of a well-designed monoplane wing.

Dissert. Abstr.

N73-16988*# California Univ., Davis. Dept. of Mechanical Engineering.

EQUATIONS OF MOTION FOR THE X-14 AIRCRAFT, PHASE 2 STUDY Quarterly Status Report, 1 Jul. - 31 Dec. 1972

Myron A. Hoffman, Walter V. Loscutoff, and J. A. Jørgensen Dec. 1972 73 p refs

(Grant NGR-05-004-051)
(NASA-CR-130760; QSR-7) Avail: NTIS HC \$5.75 CSCI 01C

A study of the control and power requirements of the X-14 VTOL aircraft is presented. The complete equations of motion for X-14 are derived. The fundamental assumption is that the aircraft is a single rigid body. The equations of motion are derived with respect to a set of axes fixed to the aircraft. Additional assumptions used are that any wind disturbances are irrotational and that the twin engines used on the aircraft rotate in the same direction at the same speed and that the engine exhaust is diverted by means of vanes to provide a direction varying thrust vector. The equations obtained are subsequently linearized about various reference conditions and numerical values for the trim parameters and the stability derivatives at these conditions are tabulated. Author

N73-16989# Advisory Group for Aerospace Research and Development, Paris (France).

STABILITY AND CONTROL

Nov. 1972 305 p refs Proceedings of the 40th Meeting of the Flight Mech. Panel of AGARD, Braunschweig West Germany, 10-13 Apr. 1972

(AGARD-CP-119) Avail: NTIS HC \$17.25

Summaries of papers presented at conferences concerning aircraft stability, control, maneuverability and design are reported.

Author

N73-16990 National Aerospace Lab., Amsterdam (Netherlands). SUMMARY OF AGARD MEETING ON PROBLEMS OF THE COCKPIT ENVIRONMENT, NOVEMBER 1968 IN AMSTERDAM, NETHERLANDS

J. J. P. Moelker In AGARD Stability and Control Nov. 1972 9 p refs

Problems related to the process of man-machine communication are discussed with emphasis on cockpit information-generation, display, and transfer. Techniques for the evaluation of cockpit geometry, display systems and cockpit workload are summarized together with the associated anthropometrical data and types of display systems. Author

N73-16991 Centre d'Essais en Vol, Bretigny-sur-Orge (France). AEROELASTIC EFFECTS FROM A FLIGHT MECHANICS STAND POINT

J. F. Renaudie In AGARD Stability and Control Nov. 1972 17 p In FRENCH

Methods for calculating the effects of aeroelasticity on aircraft flight are discussed. Data cover aerodynamics of flexible rotors,

flight dynamics of flexible aircraft, experimental determination of flexibility for flexible aircraft, stability augmentation systems, and problems of determining influence of aerodynamic forces on flexible aircraft. Transl. by E.H.W.

N73-16992 British Aircraft Corp., Preston (England). Military Aircraft Div.
SUMMARY PAPER ON SIMULATION MEETING, SPRING 1970 AT NASA RESEARCH CENTER
A. G. Barnes *In AGARD Stability and Control* Nov. 1972 5 p ref

The conference on flight simulation is summarized. Topics discussed include: simulation objectives, simulator characteristics, design of experiments, simulation results, and analysis. F.O.S.

N73-16993 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
HANDLING QUALITIES CRITERIA AND REQUIREMENTS
William E. Lamar and Terry L. Neighbor *In AGARD Stability and Control* Nov. 1972 19 p refs

Summaries of papers presented at the conference on flight qualities are presented. Topics discussed include: flying qualities for conventional and V/STOL aircraft, man-machine research, and the establishment of criteria. F.O.S.

N73-16994* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONSIDERATIONS FOR STABILITY AND CONTROL OF V/STOL AIRCRAFT: A REVIEW OF AGARD REPORT 577
Seth B. Anderson and Laurel G. Schroers (Army Mobility R and D Lab.) *In AGARD Stability and Control* Nov. 1972 10 p refs
CSSL 01B

Revisions which have been made to previous V/STOL handling qualities requirements based on criteria are discussed. A discussion of the pilot's desire for a particular characteristic is given. In addition, data and reference material are provided to back up the proposed criteria to permit the user to understand the limitations of the data on which the criteria are based. A review is included of several controversial areas including pitch control sensitivity, static longitudinal stability, roll control power, roll-yaw cross coupling, and vertical flight path control. Author

N73-16995 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
MISSION EFFECTS ON STABILITY AND MANEUVERABILITY
Charles B. Westbrook *In AGARD Stability and Control* Nov. 1972 13 p refs

The relationship between the mission requirements of a piloted aircraft and its stability and maneuverability are defined. The framework utilized in current U.S. Air Force handling qualities requirements, i.e., classification of aircraft, flight phases, levels, states, etc., is described. Examples of various aircraft designed for one mission and then utilized for other missions are given. A discussion is presented of the problems encountered when the detailed mission requirements are not clear, such as with V/STOL aircraft, reentry vehicles, etc. Problems encountered with off-design conditions and operation at the limits of the flight envelope are discussed with examples. The various methods open to the designer for achieving the proper compromises in design of an aircraft are outlined. Author

N73-16996 British Aircraft Corp., Preston (England). Military Aircraft Div.
DESIGN CONSIDERATIONS FOR THE SATISFACTORY STABILITY AND CONTROL OF MILITARY COMBAT AEROPLANES
B. R. A. Burns *In AGARD Stability and Control* Nov. 1972 28 p refs

Design criteria for achieving satisfactory stability and control for military aircraft are reviewed along with official requirements.

Some of the difficulties of designing to meet the standards of these criteria are considered. Topics discussed include longitudinal stability and control, and lateral stability and control. Author

N73-16997 Technische Hochschule, Darmstadt (West Germany).
THE EFFECTS OF THRUST CHARACTERISTICS ON LONGITUDINAL STABILITY IN SUPERSONIC FLIGHT
G. Sachs *In AGARD Stability and Control* Nov. 1972 15 p refs

The influence of the variation of thrust with speed and height on the dynamic stability of the longitudinal motion in supersonic flight is shown. The effects directly related to thrust changes are described along with the effects due to pitching moments which, associated with thrust characteristics, depend on speed and height. The thrust influence on two methods of artificial stabilization of long-term modes is also investigated. Author

N73-16998 Societe Nationale Industrielle Aerospatiale, Paris (France). Departement Recherche.
INFLUENCE OF THE MASS AND MASS DISTRIBUTION ON FLYING QUALITIES [INFLUENCE DE LA MASSE ET DE LA REPARTITION DE LA MASSE SUR LES QUALITES DE VOL]
Marc Mesniere *In AGARD Stability and Control* Nov. 1972 9 p refs *In FRENCH*

Several techniques pertinent to determining the influence of mass and mass distribution on the handling qualities of aircraft are presented. Particular attention was given to lateral and longitudinal maneuverability and the influence of inertia on the principle axis tilt angle. Several examples using a Corvett aircraft are given. Transl. by E.H.W.

N73-16999 Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
THE ROLE OF THEORY AND CALCULATIONS IN THE REFINEMENT OF FLYING QUALITIES
W. J. G. Pinsker *In AGARD Stability and Control* Nov. 1972 13 p refs

The present state of the art in handling qualities research and design is broadly surveyed with particular emphasis on the role of theory and paper studies in this field. The significance and scope of handling criteria is critically discussed as setting targets for flying qualities design. The capabilities and limitations of theory are then considered in such areas as derivative prediction, rigid-body stability and response calculations, predictions of stability under partial constraint and under active pilot control. Finally some general consideration is given to novel flying qualities problems associated with the introduction of stability and control augmentation systems. Author

N73-17000 Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost. Aerodynamics Dept.
ADJUSTMENT OF FLYING QUALITIES BY WIND TUNNEL TESTING
Tj. Schuringa *In AGARD Stability and Control* Nov. 1972 7 p

Two examples of the wind tunnel approach to the flying qualities of the Fokker F28 Fellowship aircraft are described, one dealing with the development of the elevator surface, and the other with the development of stall characteristics. Author

N73-17001 Naval Air Systems Command, Washington, D.C. Advanced Technology Section.
FLIGHT SIMULATION: A SIGNIFICANT AID IN AIRCRAFT DESIGN
Ralph C. AHarrah *In AGARD Stability and Control* Nov. 1972 17 p refs

The role of flight simulation in the development of the S-3 and F-14 aircraft is described along with the facilities used. An appraisal is included of simulation technology as applied to aircraft design. Author

N73-17002 Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

THE ROLE OF FREE-FLIGHT MODELS IN AIRCRAFT RESEARCH AND DEVELOPMENT.

R. Fail *In* AGARD Stability and Control Nov. 1972 14 p refs

The special features of free-flight models are discussed. Two examples are given of tests in the field of flight mechanics. Preparations are described for a program of tests which is about to start at RAE to investigate the low-speed stall and post-stall dynamics of aircraft. Attention is concentrated on the planning of the tests and the instrumentation and control system in the model. Some details are given of the model handling and retrieval systems. Author

N73-17003 British Aircraft Corp., Preston (England). Commercial Aircraft Div.

THE EFFECT OF ENGINE FAILURE AT SUPERSONIC SPEEDS ON A SLENDER AIRCRAFT: PREDICTED AND ACTUAL

C. S. Leyman and R. L. Scotland *In* AGARD Stability and Control Nov. 1972 8 p

The effect of engine failure on the aerodynamic characteristics of a supersonic aircraft were studied. Topics discussed include: prediction of aircraft stability derivatives, prediction of forces and moments due to engine failure, preflight simulation experience, and flight test results. F.O.S.

N73-17004 Aerospatiale Usines de Toulouse (France). **CALCULATION OF INDUCED LOAD BY VARIATION IN COURSE DURING ANY MANEUVER [CALCUL DES CHARGES INDUITES PAR LA CLEXIBILITE AU COURS D'UNE MANOEUVRE QUELCONQUE]**

A. Marsan *In* AGARD Stability and Control Nov. 1972 9 p *In* FRENCH

A general formula for calculating load influence on aircraft flexibility is presented along with illustrations. A comparison was made of the load effects in rigid and transverse flexible aircraft. Three maneuvers, - lifting moments and forces, checked pitching, and checked rolling - were used for the analysis.

Transl. by E.H.W.

N73-17005* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ACTIVE CONTROL OF AEROELASTIC RESPONSE

A. Gerald Rainey, Charles L. Ruhlin, and Maynard C. Sandford *In* AGARD Stability and Control Nov. 1972 8 p refs

Conceptual and wind-tunnel programs leading to the development of technology for applying active controls to the suppression of flutter were studied to provide a powerful tool for required safety margins for flutter in future high-performance supersonic aircraft. The nature of flutter considerations in the design of the U.S. SST prototype aircraft is described as an example of the type of application where active flutter suppression shows promise. Author

N73-17006 Aeronautical Systems Div., Wright-Patterson AFB, Ohio. B-1 Airframe Div.

PREDICTION OF AEROELASTIC HINGE MOMENT EFFECTS ON STABILITY AND CONTROLLABILITY

John W. Carlson *In* AGARD Stability and Control Nov. 1972 5 p

The effect of aeroelastic deflections on the stability and control characteristics are studied. Some examples of difficulties are shown that have resulted in control problems and aircraft limitations. Methods of predicting hinge moments are reviewed and some of the problems that arise by the use of these methods are discussed. A program for the analysis of structural deformations is described which may be used to analyze many aeroelastic problems. Author

N73-17007 Aeritalia, Turin (Italy).

CONSIDERATIONS ON THE MANUAL FLIGHT CONTROL DESIGN OF A MILITARY TRANSPORT AIRCRAFT

Antonio Filisetti and Giuseppe Ferretti *In* AGARD Stability and Control Nov. 1972 20 p refs

Criteria for designing manual control systems for military transport aircraft are presented including a guide to the choice of the manual control parameter. Practical problems concerning the nonlinear hinge moments behavior and the control force scatter with the flight conditions are discussed. Aspects of matching manual operated ailerons with hydraulically driven spoilers are emphasized along with practical methods for designing spring-tab control surfaces. Author

N73-17008 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).

POWERED CONTROLS, INFLUENCE ON STABILITY AND MANEUVERABILITY

Gerhard K. Kissel *In* AGARD Stability and Control Nov. 1972 13 p

The influence is discussed of powered controls on the dynamic and static behavior of modern high performance aircraft. The possibilities of improving the stability and maneuverability by interconnections in the various axes are considered, and an example for a modern fighter type aircraft is demonstrated. Author

N73-17009 Boeing Co., Seattle, Wash.

FLY-BY-WIRE AND ARTIFICIAL STABILIZATION DESIGN

R. L. Schoenman *In* AGARD Stability and Control Nov. 1972 13 p

The implementation of artificial stabilization to correct serious stability and control deficiencies is discussed for meeting the performance demands for aircraft which operate over a broad flight envelope such as VTOL, STOL, and SST. For this class of aircraft safety-of-flight is dependent on the integrity of these systems, and has resulted in the development of redundant system designs. The conventional SAS design approach is compared to that recommended for those vehicles which require augmentation for safety-of-flight. The impact of system redundancy on maintainability and operating costs is also discussed. A system is proposed which features integration of critical flight functions, and the use of digital computation to simplify system complexity. Author

N73-17010 Royal Aircraft Establishment, Farnborough (England). Human Engineering Div.

PILOT WORKLOAD: A CONCEPTUAL MODEL

R. G. Thorne *In* AGARD Stability and Control Nov. 1972 6 p

A conceptual model is presented for the study of the situations when, some of the crew, some of the time are unable to complete satisfactorily some of their tasks. A more realistic simulation of the difficult tasks is recommended. Author

N73-17011 Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

THE ROLE OF THEORETICAL STUDIES OF FLIGHT DYNAMICS IN RELATION TO FLIGHT TESTING

H. H. B. M. Thomas *In* AGARD Stability and Control Nov. 1972 13 p refs

It is argued that calculations have an important role to play in the planning of, the conduct of, and the analysis of flight tests. This is especially true of those areas of flight testing which involve maneuvers near limiting flight conditions in which preflight calculations are invaluable in arriving at a clearer definition of the objective of a test. Provided the aerodynamic forces acting on the aircraft can be adequately and reliably represented, there is inherent difficulty about undertaking the solution of the equations of motion in an appropriate number of degrees of freedom with the aid of available digital computers. The real problem, therefore, lies in reducing to a manageable form the output of such computer studies and thereby achieving a deeper understanding of and a more ready interpretation of the results. As an illustrative example, the longitudinal motion of an aircraft involving an extended angle-of-attack range is considered. Author

N73-17012* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

FLIGHT TEST EXPERIENCE IN AIRCRAFT PARAMETER IDENTIFICATION

Chester H. Wolowicz, Kenneth W. Iloff, and Glenn B. Gilyard /
 AGARD Stability and Control Nov. 1972 13 p refs

An automatic method for determining stability and control derivatives from flight data is presented. The technique, a modification of the Newton-Raphson method for derivative extraction, has a priori provision that makes use of initial estimates of the derivatives and provides a means of checking the validity of the results. Recommendations for applications of the method are included. Author

N73-17013 Aerospatiale Usines de Toulouse (France).
UTILIZATION OF BLACK BOXES FOR IMPROVING THE CHARACTERISTICS OF PILOTAGE DURING THE AIRCRAFT DEVELOPMENT PHASE [UTILISATION DES BOITES NOIRES POUR AMELIORER LES CARACTERISTIQUES DE PILOTAGE DURANT LA PHASE DE DEVELOPPEMENT D'UN AVION]

R. Deque /
 AGARD Stability and Control Nov. 1972 12 p
 In FRENCH

Problems encountered while trying to modify the flight control system of the Concorde aircraft during the development phase are reported. They are: (1) tendency of pilot engine to pump in a lateral direction during supersonic flight, (2) consecutive skid with motor breakdown at supersonic speed, and (3) control of the aircraft after cut off of the piloting gear. The modifications made to correct these problems are given. Transl. by E.H.W.

N73-17014* National Aeronautics and Space Administration.
 Ames Research Center, Moffett Field, Calif.
STUDY OF BUOYANCY SYSTEMS FOR FLIGHT VEHICLES
 C. Dewey Havill and Louis J. Williams Washington Dec. 1972
 62 p refs
 (NASA-TM-X-62168) Avail: NTIS HC \$5.25 CSCL 018

The performance potential of buoyant systems and flexible structures used in air vehicles for short-haul passenger transportation is discussed. The study was intended only to determine if sufficient performance potential existed, and to provide a focus for a more extensive design study, if such a study appeared desirable. A relatively conventional helium system was examined along with a more unusual configuration employing hot-air as the buoyant fluid. Both configurations were examined in the VTOL and STOL modes of operation. The helium system appears to have some superiority in the VTOL mode, while the hot-air system has a superiority in the STOL mode. Both configurations exhibit sufficient performance potential to suggest that a much more extensive design study might well be undertaken. Author

N73-17015* National Aeronautics and Space Administration.
 Ames Research Center, Moffett Field, Calif.
A PILOTTED SIMULATION STUDY OF THE EFFECTS OF CONTROLLER FORCE GRADIENT IN VTOL HOVERING FLIGHT

Emmett B. Fry, Ronald M. Gerdes, and Laurel G. Schroers Jan. 1973 35 p refs Prepared in cooperation with Army Air Mobility Res. and Develop. Lab., Moffett Field, Calif.

(NASA-TM-X-62230) Avail: NTIS HC \$3.75 CSCL 018

A study of the effect of control force gradient on the VTOL visual hovering task was conducted on the NASA-Ames Research Center Six-Degree-of-Freedom Motion Simulator. Lateral control force-gradient characteristics were evaluated in combination with three different types of stabilization systems: An unstabilized (acceleration) system, a rate-stabilized system, and two attitude-stabilized systems. The effects of gust disturbances were included in the control force evaluation for the attitude systems. A force gradient of 1.0 lb/in was within the optimum range for all control systems and conditions evaluated in this study. Author

N73-17016* National Aeronautics and Space Administration.
 Ames Research Center, Moffett Field, Calif.
APPLICATION OF MODERN CONTROL THEORY TO THE DESIGN OF OPTIMUM AIRCRAFT CONTROLLERS
 Leo J. Power Jan. 1973 12 p refs
 (NASA-TM-X-62208) Avail: NTIS HC \$3.00 CSCL 018

The synthesis procedure presented is based on the solution of the output regulator problem of linear optimal control theory

for time-invariant systems. By this technique, solution of the matrix Riccati equation leads to a constant linear feedback control law for an output regulator which will maintain a plant in a particular equilibrium condition in the presence of impulse disturbances. Two simple algorithms are presented that can be used in an automatic synthesis procedure for the design of maneuverable output regulators requiring only selected state variables for feedback. The first algorithm is for the construction of optimal feedforward control laws that can be superimposed upon a Kalman output regulator and that will drive the output of a plant to a desired constant value on command. The second algorithm is for the construction of optimal Luenberger observers that can be used to obtain feedback control laws for the output regulator requiring measurement of only part of the state vector. This algorithm constructs observers which have minimum response time under the constraint that the magnitude of the gains in the observer filter be less than some arbitrary limit. Author

N73-17017* Massachusetts Inst. of Tech., Cambridge.
 Aeroelastic and Structures Research Lab.

THE NONLINEAR INSTABILITY IN FLAP-LAG OF ROTOR BLADES IN FORWARD FLIGHT

Pin Tong Oct. 1971 67 p refs

(Contract NAS2-6175)

(NASA-CR-114524; ASRL-TR-166-2) Avail: NTIS HC \$5.50
 CSCL 01C

The nonlinear flap-lag coupled oscillation of torsionally rigid rotor blades in forward flight is examined using a set of consistently derived equations by the asymptotic expansion procedure of multiple time scales. The regions of stability and limit cycle oscillation are presented. The roles of parametric excitation, nonlinear oscillation, and forced excitation played in the response of the blade are determined. Author

N73-17018* National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT. PAN ALASKA AIRWAYS, LTD., CESSNA 310C, N1812H MISSING BETWEEN ANCHORAGE AND JUNEAU, ALASKA, 16 OCTOBER 1972

31 Jan. 1973 26 p refs

(NTSB-AAR-73-1) Avail: NTIS HC \$3.50

A Cessna 310C disappeared on a flight from Anchorage to Juneau, Alaska, on October 16, 1972. In addition to the pilot, three passengers, including two U. S. Congressmen, were aboard the aircraft. After takeoff from Anchorage, the pilot filed a Visual Flight Rules flight plan for the flight to Juneau. The weather conditions along the proposed route were not conducive to flight under Visual Flight Rules criteria. An extensive air, sea, and land search was conducted during the 39 day period following October 16, 1972. Nothing was found that could be identified with either the aircraft or its occupants. The probable cause of this accident, from the evidence presently available, is undetermined. Author

N73-17019* Cranfield Inst. of Technology (England). Coll. of Aeronautics.

AEROPLANE DESIGN STUDY STOL AIRLINER (A71). PART 1: CONFIGURATION DESCRIPTION AND DATA

D. Howe and R. E. Ward Jun. 1972 32 p refs

(Cranfield-Aero-12-Pt-1) Avail: NTIS HC \$3.75

The proposed design of a short takeoff and landing aircraft for short haul passenger operation is presented. The low speed lift and control problems of a short takeoff aircraft are investigated. The aerodynamic configurations and predicted performance of the aircraft are described. Author

N73-17020* National Aeronautics and Space Administration.
 Ames Research Center, Moffett Field, Calif.

VERTICAL MOTION REQUIREMENTS FOR LANDING SIMULATION

Richard S. Bray Feb. 1973 24 p

(NASA-TM-X-62236) Avail: NTIS HC \$3.25 CSCL 01B

Tests were conducted to determine the significance of vertical acceleration cues in the simulation of the visual approach and landing maneuver. Landing performance measures were

obtained for four subject pilots operating a visual landing simulation device which provides up to plus or minus 40 feet of vertical motion. Test results indicate that vertical motion cues are utilized in the landing task, and that they are particularly important in the simulation of aircraft with marginal longitudinal handling qualities. To assure vertical motion cues of the desired fidelity in the landing tasks, it appears that a simulator must have excursion capabilities of at least plus or minus 20 feet.

Author

N73-17021* Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

THE DESIGN OF STABILITY AUGMENTATION SYSTEMS FOR DECOUPLING AIRCRAFT RESPONSES Ph.D. Thesis - Purdue Univ. Final Report, Jan. 1970 - Dec. 1971 Rhall E. Pope Jun. 1972 154 p refs Sponsored in part by NASA

(AF Proj. 8219)

(NASA-CR-130543; AD-747017; AFFDL-TR-72-63) Avail: NTIS HC \$9.75 CSCL 01/3

Tactical aircraft with STOL capability exhibit undesirable coupled response during the landing phase of flight. A simplified method for designing a stability augmentation system which eliminates the coupling effects is demonstrated. The method is based on Gilbert's decoupling theory which utilizes a feedback control law to obtain a set of single input, single output subsystems. The augmentation system can be designed to provide either command rate or command angle authority in the three rotational axes. Analyses is facilitated through the use of two computer programs, the first of which determines the class of control laws which will decouple a system. The second computer program determines, through transient response analysis, the values of the transfer function parameters required to satisfy response criteria. The results of a piloted simulation which analyzed several decoupled configurations is also presented.

Author (GRA)

N73-17023# Naval Air Engineering Center, Philadelphia, Pa. Engineering Dept.

ENVIRONMENTAL TEMPERATURE AND AIRCRAFT COMPATIBILITY STUDIES

G. Geaman and W. Goon Oct. 1972 78 p refs

(AD-752018; NAEC-ENG-7780) Avail: NTIS CSCL 01/3

A study of both landbased and shipboard tests of the F14A aircraft with the MK7 Jet Blast Deflector to investigate the effect of backflow of jet exhaust on the aircraft being launched and the resulting environmental temperature aft and alongside the JBD. Configuration for shipboard installation and desired mode of operation are recommended. Areas for further effort to achieve improved compatibility are also presented.

Author (GRA)

N73-17024# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.

F-111 CRACK-PROPAGATION SENSITIVITY ANALYSES

Neil McManus and Troy T. King Mar. 1972 32 p refs

(AF Proj. 324A)

(AD-752223; ASD-TR-71-89) Avail: NTIS CSCL 01/3

The report presents the results of sensitivity analyses conducted on the F-111 aircraft. The objective of the investigation was to identify and assess those parameters which significantly affect the crack propagation characteristics of high strength steel and to relate these results to the F-111 aircraft. The study was done by parametric analyses, and the results are presented graphically in terms of subcritical crack growth interval versus the independent parameter. The analyses showed where emphasis should be placed to control the parametric variables and to minimize a structural failure caused by a pre-existing flaw. In particular, the greatest variation in crack growth interval was a function of initial flaw size.

Author (GRA)

N73-17025# Technology, Inc., Dayton, Ohio.

T-38 STRUCTURAL FLIGHT LOADS DATA FOR JUNE 1970 - DECEMBER 1971 Final Report, 1 Jun. 1970 - 31 Mar. 1972

Larry E. Clay and Ronald I. Rockafellow Wright-Patterson AFB, Ohio ASD Jun. 1972 149 p refs

(Contracts F33657-70-D-1161; F33657-71-C-0662)

(AD-751968; ASD-TR-72-54) Avail: NTIS CSCL 01/3

In a fifth part of a continuing T-38 Service Loads Recording Program to cover the period from 1 June 1970 through 31 December 1971, 4265 hours of VGH data were recorded by A/A24U-10 magnetic tape recording systems installed in twenty-eight T-37 aircraft: 22 fleet and 6 lead-the-force T-38's operating from Williams, Reese, and Moody Air Force Bases. As in previous reports, the data presentation includes curves showing normal load factor (nz) exceedances above each nz level per thousand flight hours. Only one (nz) exceeded 7.8 (design limit is 7.33), and the comparison of the exceedance curves for the current and previous programs substantiated that the T-38 (nz) spectrum had remained unchanged during the T-38 SLRP.

Author (GRA)

N73-17026# Hughes Aircraft Co., Culver City, Calif. Engineering Equipment Div.

STUDY OF A HIGHLY RELIABLE PILOT'S VERTICAL DISPLAY SYSTEM Final Report, 8 Jun. 1970 - 8 Jul. 1972 J. L. Heard, H. L. Bjelland, and E. Streeter Oct. 1972 185 p refs

(Contract N62269-71-C-0510)

(AD-752510; HAC-P72-104R) Avail: NTIS CSCL 01/3

The study develops the requirements for a highly reliable cathode ray tube type of Vertical Display Systems (VDS) for use in Advanced Navy All-Weather Aircraft of the 1980's. First the operational requirements study identified the detailed information required for the VDS. The performance requirements section converts the general operational requirements into specific mechanization requirements. Mechanization tradeoffs then evaluate specific candidate designs and selects the optimum design mechanization for the VDS. A reliability analysis is also performed and aids in making the hardware tradeoffs. A TV type (resonant) indicator is selected to be optimum for the VDS application along with an in-raster or digital television symbol generator. Also two candidate digital scan converter PPI to TV mechanizations are recommended for further evaluation.

Author (GRA)

N73-17027# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

TEST PLAN FOR NON-DESTRUCTIVE INSPECTION INVESTIGATION OF THE CATAPULT AND ARRESTED LANDING CARRY-THROUGH STRUCTURE OF THE E-2 AIRCRAFT Progress Report

Louis Berman 15 Jul. 1972 11 p

(AD-752492) Avail: NTIS CSCL 01/3

Non-destructive inspection techniques, for utilization by the NAVAIWORKFAC (Naval Air Rework Facility), are required to inspect the catapult and arrested landing carry-through structure of the E-2 airplane. This program proposes an NDI investigation to be performed during the E-2 fatigue tests.

Author (GRA)

N73-17028# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

TEST PLAN REPORT FOR CATAPULT FATIGUE TEST OF THE MODEL C-2A AIRPLANE

Edward F. Kautz 6 Oct. 1972 19 p refs

(AD-752493; NADC-72197-VT) Avail: NTIS CSCL 01/3

A laboratory fatigue test will be performed on a C-2 airframe to determine whether the airframe will sustain the effects of 3000 catapult launches without structural failure.

Author (GRA)

N73-17029# Forest Products Lab., Madison, Wis.

DESIGN PARAMETERS FOR TORSION OF SANDWICH STRIPS HAVING TRAPEZOIDAL RECTANGULAR, AND TRIANGULAR CROSS SECTIONS

H. M. Montrey and Edward W. Kuenzi 1972 41 p refs Sponsored by Air Force and FAA

(AD-752619; FSRP-FPL-156) Avail: NTIS CSCL 01/3

Solutions for the elastic torsion of sandwich strips having triangular, rectangular, or trapezoidal cross sections are presented analytically in terms of suitable design parameters. Data obtained

from resulting expressions are presented in a series of design curves for normalized values of torsional stiffness and maximum facing and core shear stresses. The analysis is based on the Saint Venant theory of torsion. The sandwich facings are idealized as identical, thin, isotropic membranes, while the core's elastic behavior is characterized by a single transverse modulus of rigidity. Author (GRA)

N73-17030# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

BI-NORMAL COORDINATES IN DISCRETE SYSTEMS WITH APPLICATION TO AN AIRCRAFT SHIMMY PROBLEM

Lynn C. Rogers Jun. 1972 265 p refs
(AF Proj. 1367)

(AD-752548; AFFDL-TR-72-79) Avail: NTIS CSCL 01/3

The use of bi-normal coordinate theory in the analysis of practical discrete systems provides the substantial benefits of conceptual value/physical insight, computational utility, and enhanced redesign capability. These benefits are explained and demonstrated in the present effort with attention to practical considerations. Section 1 extends the theory and presents the new material together with some previously available results in a coordinated manner. In particular, the nature of response in a single homogenous phasor mode is described in detail. Also, an expression for the derivative of an eigenvalue is developed and explained. Section 2 reports the analysis of an aircraft nosegear shimmy problem using bi-normal coordinate methods. Stability boundaries, mode shapes, and sensitivities to parameter changes are presented. Derivatives of eigenvalues are used in Section 3 to illustrate automated minimum weight design for a shimmy-free nosegear. Recommendations for further research are made. Author (GRA)

N73-17031# Boeing Co., Philadelphia, Pa. Vertol Div.
AN INVESTIGATION OF HELICOPTER TRANSMISSION NOISE REDUCTION BY VIBRATION ABSORBERS AND DAMPING Final Report

H. Sternfeld, J. Schairer, and R. Spencer Ft. Eustis, Va. Army Air Mobility Res. and Develop. Lab. Aug. 1972 163 p refs
(Contract DAAJ02-71-C-0020; DA Proj. 1F1-62204-A-142)
(AD-752579; USAAMRDL-TR-72-34) Avail: NTIS CSCL 01/3

A test program was conducted to evaluate the effect of dynamic absorbers and damping on the noise generated by a CH-47 rotor transmission. Comparison was made between predicted and measured results, and a method for comparing the efficiency of various methods of transmission noise reduction was developed. Gear damping was achieved by filling the gear shafts with Viton, and by a ring of Viton on the spiral bevel ring gear. Constrained layer damping was also used on the outside of the planetary ring gear. Author (GRA)

N73-17032# Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.

HELICOPTER ROTOR WAKE GEOMETRY AND AIRLOADS AND HELICOPTER ROTOR WAKES Final Scientific Technical Report, 6 Jun. 1971 - 6 Jun. 1972

M. P. Scully and J. P. Sullivan Aug. 1972 67 p refs
(Contract N00019-71-C-0220; MIT Proj. DSR-73032)
(AD-752628; TR-179) Avail: NTIS CSCL 14/2

Computer programs have been developed for the calculation of helicopter rotor tip vortex geometry in hover and forward flight and for the calculation of helicopter rotor harmonic airloads in forward flight. Calculated forward flight tip vortex geometries compare well in general with experimental smoke studies although there are differences in detail. The hovering tip vortex geometry agrees qualitatively with experiment but does not move downward fast enough. Airloads were computed using both the classical rigid wake assumption and the distorted tip vortex geometry obtained from the computer program. When compared with experimental airloads measurements the rigid wake airloads give better results than the distorted wake airloads. Author (GRA)

N73-17033# Northrop Corp., Hawthorne, Calif. Aircraft Div.
V/STOL AIRCRAFT AERODYNAMIC PREDICTION METHODS INVESTIGATION. VOLUME 1: THEORETICAL DEVELOPMENT OF PREDICTION METHODS Final Report, 1 May 1969 - 31 Jan. 1972

Peter T. Wooler, Hsiao C. Kao, Myles F. Schwendemann, Howard R. Wasson, and Henry Ziegler Jan. 1972 238 p refs
(Contract F33615-69-C-1602; AF Proj. 6988T)
(AD-752557; NOR-72-9-Vol-1; AFFDL-TR-72-26-Vol-1) Avail: NTIS CSCL 01/3

Analytical engineering methods are developed for use in predicting the static and dynamic stability and control derivatives and force and moment coefficients of lift-jet, lift-fan, and vectored thrust V/STOL aircraft in the hover and transition flight regimes. The methods take into account the strong power effects, large variations in angle of attack and sideslip, and changes in aircraft geometry that are associated with high disk loaded V/STOL aircraft operating in the aforementioned flight regimes. The theoretical development of the prediction methods is presented in this volume. Author (GRA)

N73-17034# Northrop Corp., Hawthorne, Calif. Aircraft Div.
V/STOL AIRCRAFT AERODYNAMIC PREDICTION METHODS INVESTIGATION. VOLUME 2: APPLICATION OF PREDICTION METHODS Final Report, 1 May 1969 - 31 Jan. 1972

Peter T. Wooler, Hsiao C. Kao, Myles F. Schwendemann, Howard R. Wasson, and Henry Ziegler Jan. 1972 249 p refs
(Contract F33615-69-C-1602; AF Proj. 6988T)
(AD-752558; NOR-72-9-Vol-2; AFFDL-TR-72-26-Vol-2) Avail: NTIS CSCL 01/3

Analytical engineering methods are developed for use in predicting the static and dynamic stability and control derivatives and force and moment coefficients of lift-jet, lift-fan, and vectored thrust V/STOL aircraft in the hover and transition flight regimes. The aircraft configurations studied have a conventional wing, fuselage and empennage. The prediction methods are applied to a number of V/STOL configurations in this volume. Author (GRA)

N73-17035# Northrop Corp., Hawthorne, Calif. Aircraft Div.
V/STOL AIRCRAFT AERODYNAMIC PREDICTION METHODS INVESTIGATION. VOLUME 3: MANUAL FOR COMPUTER PROGRAMS Final Report, 1 May 1969 - 31 Jan. 1972

Peter T. Wooler, Hsiao C. Kao, Myles F. Schwendemann, Howard R. Wasson, and Henry Ziegler Jan. 1972 207 p
(Contract F33615-69-C-1602; AF Proj. 6988T)
(AD-752559; NOR-72-9-Vol-3; AFFDL-TR-72-26-Vol-3) Avail: NTIS CSCL 01/3

Analytical engineering methods are developed for use in predicting the static and dynamic stability and control derivatives and force and moment coefficients of lift-jet, lift-fan, and vectored thrust V/STOL aircraft in the hover and transition flight regimes. The aircraft configurations studies have a conventional wing, fuselage and empennage. The prediction methods are suitable for use by design personnel during the preliminary design and evaluation of V/STOL aircraft of the type previously mentioned. Details and listings of the computer programs associated with the prediction methods are given in the volume. Author (GRA)

N73-17036# Northrop Corp., Hawthorne, Calif. Aircraft Div.
V/STOL AIRCRAFT AERODYNAMIC PREDICTION METHODS INVESTIGATION. VOLUME 4: LITERATURE SURVEY Final Report, 1 May 1969 - 31 Jan. 1972

Peter T. Wooler, Hsiao C. Kao, Myles F. Schwendemann, Howard R. Wasson, and Henry Ziegler Jan. 1972 79 p refs
(Contract F33615-69-C-1602; AF Proj. 6988T)
(AD-752563; NOR-72-9-Vol-4; AFFDL-TR-72-26-Vol-4) Avail: NTIS CSCL 01/3

Analytical engineering methods are developed for use in predicting the static and dynamic stability and control derivatives and force and moment coefficients of lift-jet, lift-fan, and vectored thrust V/STOL aircraft in the hover and transition flight

regimes. The prediction methods are suitable for use by design personnel during the preliminary design and evaluation of V/STOL aircraft of the type previously mentioned. The results of a literature survey are presented in this volume. Author (GRA)

N73-17039* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF REDUCING ROTOR BLADE INLET DIAMETER ON THE PERFORMANCE OF A 11.66-CENTIMETER RADIAL-INFLOW TURBINE
 Milton G. Kofskey and Jeffrey E. Haas Washington Mar. 1973 20 p refs Prepared in cooperation with Army Air Mobility R and D Lab., Cleveland, Ohio
 (NASA-TM-X-2730; E-7119) Avail: NTIS HC \$3.00 CSCL 21E

The effect of increased rotor blade loading on turbine performance was investigated by reducing rotor blade inlet diameter. The reduction was made in four stages. Each modification was tested with the same stator using cold air as the working fluid. Results are presented in terms of equivalent mass flow and efficiency at equivalent design rotative speed and over a range of pressure ratios. Internal flow characteristics are shown in terms of stator exit static pressure and the radial variation of local loss and rotor-exit flow angle with radius ratio. Included are velocity diagrams calculated from the experimental results. Author

N73-17046* Garrett Corp., Phoenix, Ariz. AiResearch Manufacturing Div.
A SECONDARY POWER SYSTEM STUDY FOR ADVANCED ROTARY-WING AIRCRAFT Final Technical Report, 1 Jun. 1970 - 31 May 1971
 Bernard H. Nicholls Aug. 1972 335 p
 (Contract DAAJ02-70-C-0048; DA Proj. 1G1-82203-D-144)
 (AD-751854; SY-6103-R; USAAMRD-TR-72-13) Avail: NTIS CSCL 10/2

A study was performed to define and evaluate secondary power systems for an advanced Army rotary-wing aircraft, using existing technology and two advanced technology levels. The basic aircraft mission, performance penalty parameters, and system components are defined. From a total of 162 candidate systems, 36 were selected for detailed comparisons. Evaluation parameters included incremental takeoff gross weight, system weight, volume, reliability, maintainability, availability, power APU that drives into the aircraft accessory gearbox with two electrical generators and two hydraulic pumps. Main engines are started pneumatically by bleed air from the APU. Cockpit cooling was an optional addition, and an air-cycle system was selected. Author (GRA)

N73-17059* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MACHINING OF LOW PERCENTAGE BERYLLIUM COPPER ALLOYS
 John G. Habermeyer In: Proc. of the Ann. Conf. of NASA Clinic Directors, Environ. Health Off. and Med. Program Advisors 1969 p 117-120
 CSCL 06T

Airborne beryllium sampling during machining of low percentage beryllium-copper alloys shows that normal dry machining creates 45.2 microgram/cu m of airborne beryllium in the casting operators breathing zone and 2.3 microgram/cu m in an adjacent machine working area. A small vacuum system placed over the tool effectively removes airborne beryllium in the breathing zone sample to 0.2 microgram/cu m. G.G.

N73-17163* Federal Aviation Administration, Washington, D.C.
ENGINEERING AND DEVELOPMENT PROGRAM PLAN: AIR TRAFFIC CONTROL SURVEILLANCE RADAR
 Harry C. Moses Dec. 1972 65 p refs
 (FAA-ED-02-1) Avail: NTIS HC \$5.25

The role of the primary radar system in air traffic control operations is discussed. Emphasis is placed on the performance deficiencies and the technical development programs undertaken to eliminate the deficiencies. The compliance of the radar with the air traffic control surveillance requirements is analyzed.

Author

N73-17168* Colorado Univ., Boulder.
FLIGHT SAFETY ASPECTS OF PRECISION RADAR NEAR AIR BASES IN BIRD-AIRCRAFT COLLISION AVOIDANCE
 Technical Report, 18 Jun. 1970 - 1 Feb. 1972
 Warren L. Flock Kirtland AFB, N. Mex. AFWL Oct. 1972. 67 p refs
 (Contract F29601-70-C-0076)
 (AD-751985; AFWL-TR-72-25) Avail: NTIS CSCL 17/9

The utility of a GEC-AEI No. 654 radar for warning of bird hazards at airfields has been evaluated at Gunbarrel Hill and Valmont Reservoir, near Boulder, Colorado, from 16 March to 19 December 1971. Morning and evening flights of Mallards, Canada Geese, etc., provide good test radar targets at these locations. The 654 radar is useful as it is, but improvements are recommended to allow detection of birds at greater ranges. Some Doppler radar signature data were also taken with a CW radar at Baller Lake in spring 1971. Experience with this radar provides a basis for recommending further development of signature capability. Such capability should allow determining quickly if a target is caused by birds or not, the type or size of bird, and whether the echo is from one or a small or large number of birds. Author (GRA)

N73-17170* Lincoln Lab., Mass. Inst. of Tech., Lexington.
A THEORY FOR OPTIMAL MOVING TARGET INDICATOR (MTI) DIGITAL SIGNAL PROCESSING, SUPPLEMENT 1
 Robert J. McAulay 31 Oct. 1972 22 p refs
 (Contract F19628-73-C-0002; AF Proj. 649L)
 (AD-751923; TN-1972-14-Suppl-1; ESD-TR-72-243-Suppl-1) Avail: NTIS CSCL 17/9

In the report, A Theory for Optimal MTI Digital Signal Processing. Part I. Receiver Synthesis, (1), the problem of eliminating scanning ground clutter from an aircraft surveillance radar was examined from a statistical decision theoretical point of view. An optimum processor was derived which could be approximated by a clutter filter followed by a discrete Fourier transform (DFT). In the report, additional numerical work is documented that compares the performance of the pulse cancellers with feedback and the DFT with that of the optimum processor. The issue of coherent vs incoherent integration gain is considered by comparing the filters only on their ability to reject clutter. A clutter rejection improvement factor is defined and used to compare the various filters. It is shown that the pulse cancellers can be quite effective in rejecting clutter provided the input clutter power is not too large and that additional gains are possible using the DFT. Author (GRA)

N73-17178* Lincoln Lab., Mass. Inst. of Tech., Lexington.
DIVERSITY TECHNIQUES FOR AIRBORNE COMMUNICATIONS IN THE PRESENCE OF GROUND REFLECTION MULTIPATH
 Henry Berger and James E. Evans Sep. 1972 151 p refs
 (Contract F19628-73-C-0002; AF Proj. 649)
 (AD-752249; TN-1972-27; ESD-TR-72-216) Avail: NTIS CSCL 17/2

The signal power reduction due to multipath fading is an important design consideration in the development of air-air and ground-air communications links at L-band. A first order mathematical model of ground reflection multipath is used to predict the relationship between the depth of fading and environmental parameters such as surface roughness and the terminal positions relative to earth. The model is then used to investigate two techniques for reducing the loss in received signal power: frequency diversity and antenna height diversity. A measurement program to experimentally evaluate the applicability of antenna height diversity is outlined. Author (GRA)

N73-17221# Systems Technology Center, Los Angeles, Calif.
STUDY OF CAPABILITIES, NECESSARY CHARACTERISTICS AND EFFECTIVENESS OF PILOT GROUND TRAINERS.
VOLUME 1: MAIN TEXT Final Report, Jul. 1970 - Jun. 1971

Peter Stanek Jan. 1973 261 p refs
 (Contract DOT-FA70NA-506; Proj. 502-103-10X)
 (FAA-NA-72-102-Vol-1; STC-16001-Vol-1) Avail: NTIS HC \$15.25

An experiment was conducted to test the capabilities, necessary characteristics, and effectiveness of pilot ground trainers in developing primary aeronautical skills, those maneuvers and procedures limited to aircraft, single-engine, land. During the first phase of the experiment, 30 subjects were trained to proficiency, fifteen in aircraft only and fifteen in combined ground trainer and aircraft. During the next phase, 20 of the original 30 were trained to proficiency, 10 in each group. A third phase of the experiment tested additional subjects in various procedures with varying levels of simulator capability. The results of the experiment show which maneuvers and procedures may be taught effectively and efficiently in a ground trainer. Author

N73-17222# Systems Technology Center, Los Angeles, Calif.
STUDY OF CAPABILITIES, NECESSARY CHARACTERISTICS AND EFFECTIVENESS OF PILOT GROUND TRAINERS.
VOLUME 2: ADDENDUM, SUMMARY OF FLIGHT INSTRUCTORS VIEWS Final Report, Jul. 1970 - Jun. 1971
 Peter Stanek Jan. 1973 40 p refs
 (Contract DOT-FA70NA-506; Proj. 502-103-10X)
 (FAA-NA-72-102-Vol-2-Add; STC-16001-Vol-2-Add) Avail: NTIS HC \$4.00

N73-17223*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
A STUDY ON AIRCRAFT MAP DISPLAY LOCATION AND ORIENTATION
 D. Baty, T. Wempe, and E. Huff Jan. 1973 88 p refs
 (NASA-TM-X-62198) Avail: NTIS HC \$6.50 CSCL 14B

Six airline pilots participated in a fixed-based simulator study to determine the effects of two horizontal situation display (HSD/map) panel locations relative to the vertical situation display (VSD), and of three map orientations on manual piloting performance. Pilot comments and opinions were formally obtained. Significant performance differences were found between wind conditions and among pilots but not between map locations and orientations. The results also illustrate the potential tracking accuracy of such a display. Recommendations concerning display location and map orientation are made. Author

N73-17233# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
EVALUATION OF HARVEY ALUMINUM 1-BY 12-FT EXTRUDED LIGHT DUTY LANDING MAT WITH SYMMETRICAL BUTT TYPE END CONNECTORS Final Report
 Hugh L. Green Oct. 1972 70 p refs Sponsored in part by AFWL
 (DA Proj. 1G6-64717-D-H01; AF Proj. 6111A)
 (AD-752079; AEWES-Misc-Paper-S-72-38) Avail: NTIS CSCL 01/5

The investigation reported herein was conducted to evaluate an extruded aluminum alloy landing mat. The 1-by 12-ft mat is a one-piece hollow extrusion fabricated from 6063 aluminum alloy artificially aged to the T6 condition and weights 2.81 lb per square foot of placing area. The mat panels are interlocked along the sides by means of a hinge-type connector, the components of which are integral parts of the basic extrusion. End connectors, which are composed of 6061-T6 extruded aluminum connectors with integral inserts welded to the basic panel using the electron beam welding method, consist of symmetrical butt-type sections that are secured by a locking bar after individual panels have been joined together. The

investigation consisted of laboratory, traffic, and skid tests to obtain information for use in evaluating Harvey mat for potential use as a light-duty landing mat. Author (GRA)

N73-17235# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.
THE DEVELOPMENT OF A WIND TUNNEL FACILITY FOR THE STUDY OF V/STOL NOISE
 Paul Bauer and Sheila Widnall Aug. 1972 29 p refs
 (Contract DAHCO4-69-C-0086)
 (AD-751857; FTL-R72-6; AROD-8713-2-E) Avail: NTIS CSCL 14/2

An open-jet wind tunnel operating within an anechoic chamber was developed for the purpose of the study of V/STOL noise mechanisms. An existing low-speed conventional hardwalled wind tunnel was modified to operate as an open-jet tunnel; an anechoic chamber was then constructed around the test section. The resulting aerodynamic and acoustic characteristics of the tunnel are discussed. Author (GRA)

N73-17247# Carleton Univ., Ottawa (Ontario). Div. of Aerothermodynamics.
AIRCRAFT TRAILING VORTICES: A SURVEY OF THE PROBLEM

Z. El-Ramly Nov. 1972 195 p refs
 (ME/A-72-1) Avail: NTIS HC \$11.75

A survey of aircraft trailing vortices is presented. Only vortices shed from high aspect ratio straight or sweptback wings are considered. A brief description of the formation and behavior of vortex systems is provided. The stability of a trailing vortex pair is analyzed. The effects of buoyancy on the motion of wing tip vortices and the vortex breakdown phenomenon are discussed. Author

N73-17252 ARO, Inc., Arnold Air Force Station, Tenn.
EJECTOR DESIGN FOR A VARIETY OF APPLICATIONS
 Delbert Taylor In AGARD Supersonic Ejectors Nov. 1972 p 103-163 refs
 (Contract F40600-69-C-0001)

Methods and techniques developed to improve the performance and applications of various ejector designs are examined. Data cover fixed value simple design and variable area/variable pressure ejectors. E.H.W.

N73-17258*# Lockheed-California Co., Burbank.
RESEARCH ON UNSTEADY TRANSONIC FLOW THEORY
 James D. Revell Feb. 1973 108 p refs
 (Contract NAS1-11566)
 (NASA-CR-112114) Avail: NTIS HC \$7.50 CSCL 20D

A two-dimensional theory is considered for the unsteady flow disturbances caused by aeroelastic deformations of a thick wing at high subsonic freestream Mach numbers, having a single, internally embedded supercritical (locally supersonic) steady flow region adjacent to the low pressure side of the wing. The theory develops a matrix of unsteady aerodynamic influence coefficients (AICs) suitable as a strip theory for aeroelastic analysis of large aspect ratio thick wings of moderate sweep, typical of a wide class of current and future aircraft. The theory derives the linearized unsteady flow solutions separately for both the subcritical and supercritical regions. These solutions are coupled together to give the requisite (wing pressure-downwash) AICs by the intermediate step of defining flow disturbances on the sonic line, and at the shock wave; these intermediate quantities are then algebraically eliminated by expressing them in terms of the wing surface downwash. Author

N73-17259*# Scientific Translation Service, Santa Barbara, Calif.
PROBLEM OF UNIFORM JET FLOW AROUND AN AIRFOIL
 E. G. Shifrin Washington NASA 22 Feb. 1973 12 p refs
 Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza (USSR), Jul. - Aug. 1972 p 162-165

(Contract NASw-2483)

(NASA-TT-F-14813) Avail: NTIS HC \$3.00 CSCL 20D

A uniform jet flowing around an airfoil with a separated shock wave is examined for a case of low supersonic velocities, of the incident flow where entropy changes at the shock wave may be neglected. Shapes of minimal regions of influence of the mixed flow are examined for both convex and concave profiles.

Author

N73-17266# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

THE INFLUENCE OF AERODYNAMIC DECELERATORS ON SUPERSONIC WAKES: WITH AN APPLICATION OF THE GAS HYDRAULIC ANALOGY Final Technical Report, Apr. 1965 - Dec. 1969

Charles A. Babish, III Aug. 1972 105 p refs

(AD-751982; AFFDL-TR-72-54) Avail: NTIS CSCL 01/3

Two-body performance characteristics can be predicted with a reasonable degree of accuracy for deployable aerodynamic decelerators operating in conventional supersonic wakes. However, under certain geometric and flight conditions, the decelerator can modify the base flow region of the forebody, thus invalidating the performance prediction techniques. A literature review, supplementary wind tunnel tests, and a large number of shallow water tow table tests were performed to obtain a description of the process of wake modification and identify those parameters that influence the process.

Author (GRA)

N73-17270# Naval Postgraduate School, Monterey, Calif.
SMOKE AND HELIUM BUBBLE VISUALIZATION STUDIES OF INCOMPRESSIBLE FLOW PAST A JET-FLAP AIRFOIL M.S. Thesis

John Patrick Costello, II Jun. 1972 58 p refs

(AD-752012) Avail: NTIS CSCL 14/2

An exploratory low speed visualization study was performed in the wind tunnel on a jet-flapped airfoil to evaluate a test facility for future work and to compare an old and a relatively new flow visualization technique. These techniques are smoke flow and helium bubble flow. The study was conducted using various tunnel speeds and blowing rates for the jet flap. The varying of these parameters and the complexity of the jet flap flow allowed for the evaluation. As a result of many photographs taken, a comparison was made between predicted jet stream deflection and the deflections measured on photographs.

Author (GRA)

N73-17271# Aerospace Research Labs., Wright-Patterson AFB, Ohio. Fluid Dynamics Facilities Research Lab.

SHOCK DETACHMENT FROM THE LEADING EDGE OF DELTA WINGS Final Scientific Report

Kenneth F. Stetson and Norman E. Scaggs May 1972 20 p refs

(AF Proj. 7065)

(AD-752208; ARL-72-0079) Avail: NTIS CSCL 20/4

Angles of attack for shock wave detachment from the sharp leading edge of five delta wing models with flat compression surfaces were determined experimentally and the results are compared with analytical prediction methods. The wind tunnel experiments were performed at a free stream Mach number of 14.2 and a free stream Reynolds number per foot of 62,000. The angle of attack for shock wave detachment was experimentally determined by observing the flow of oil from the compression side of the model around the leading edge.

Author (GRA)

N73-17278# Applicazioni e Ricerche Scientifiche, Milan (Italy).
MODELS FOR GAS SURFACE INTERACTIONS AND COMPUTATION OF AERODYNAMIC COEFFICIENTS Interim Scientific Report, 1 Aug. 1971 - 31 Jul. 1972

Carlo Cercignani 31 Jul. 1972 25 p refs

(Contract F44620-71-C-0121; AF Proj. 9783)

(AD-752245; AFOSR-72-2202TR) Avail: NTIS CSCL 20/4

The report is devoted to summarizing the research work carried out on models for gas surface interaction, and computation of aerodynamic coefficient for some simple geometrical shapes and high Mach number flow past thin, almost specularly reflecting airfoils.

Author (GRA)

N73-17279# Naval Ordnance Lab., White Oak, Md.
DISTORTION OF NEAR-SONIC SHOCKS BY WEAKLY TURBULENT LAYERS

Leonard S. Taylor and Ralph E. Phinney 21 Sep. 1972 26 p refs

(NOL Proj. 324/FAA)

(AD-752472; NOLTR-72-225) Avail: NTIS CSCL 20/1

The focusing effects of turbulence in the propagation medium upon near-sonic shocks are studied by extending the theory of shock dynamics to a medium with random temperature and pressure variations. A perturbation procedure is used to solve the resulting nonlinear partial differential equation. The results are applied in a discussion of sonic boom distortion in the terrestrial boundary layer.

Author (GRA)

N73-17562*# Air Force Avionics Lab., Wright-Patterson AFB, Ohio.

LIGHTNING AND STATIC ELECTRICITY CONFERENCE

Dec. 1972 694 p refs Conf. held at Las Vegas, Nev., 12-15 Dec. 1972; sponsored by AFAL and SAE

(AD-752551; AFAL-TR-72-325) Avail: NTIS CSCL 01/2

The document contains the text of unclassified papers presented at the 1972 Conference on Lightning and Static Electricity, held 12-15 December 1972. The papers document the discussion of the theoretical aspects of both lightning and atmospheric electrification. In addition, the practical control of adverse effects is addressed relative to aerospace vehicles and installations. Sessions include fundamental aspects, missiles and spacecraft, aircraft, advanced composites, fuels, and lightning simulation.

Author (GRA)

N73-17570# Cranfield Inst. of Technology (England). Coll. of Aeronautics.

A COMPARATIVE ASSESSMENT OF THREE METHODS OF MEASUREMENT OF PRESSURE ERROR CORRECTIONS

M. E. Eshelby Jun. 1972 25 p refs

(Cranfield-Aero-11) Avail: NTIS HC \$3.25

Three methods of evaluating the pressure error of an aircraft pitot-static system are described, and the relative merits of each method are compared. The determination of static pressure error by a trailing cone is considered as a method suitable for use on light aircraft, and comparisons are made between the pressure error measured by the cone and other methods.

Author

N73-17592*# Boeing Commercial Airplane Co., Seattle, Wash.
DEVELOPMENT AND TESTING OF IMPROVED POLYIMIDE ACTUATOR ROD SEALS AT HIGHER TEMPERATURES FOR USE IN ADVANCED AIRCRAFT HYDRAULIC SYSTEMS

E. D. Robinson, A. W. Waterman, and W. G. Nelson 28 Feb. 1972 39 p refs

(Contract NAS3-16733)

(NASA-CR-121124; D6-41114) Avail: NTIS HC \$4.00 CSCL 11A

Polyimide second stage rod seals were evaluated to determine their suitability for application in advanced aircraft systems. The configurations of the seals are described. The conditions of the life cycle tests are provided. It was determined that external rod seal leakage was within prescribed limits and that the seals showed no signs of structural degradation.

Author

N73-17654# Royal Aircraft Establishment, Farnborough (England).

FABRIC PROPERTIES AND THE WEAR OF HOVERCRAFT FINGERS

J. E. Swallow, J. H. Cadwell, and M. Webb Oct. 1971 27 p refs

(RAE-TR-71210; BR-27693) Avail: NTIS HC \$3.50

The wear of fingers made from 16 types of coated fabric was studied on an SRN 5 hovercraft. Laboratory determinations of a number of fabric properties were made, and the results correlated with wear behavior, using correlation and factor analysis techniques. The extent to which the laboratory tests enable wear to be predicted was also investigated. ESRO

N73-17681# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.
INVESTIGATION OF THE EFFECTS OF LIQUID OXYGEN ON CHEMICALLY TREATED SURFACES OF ALUMINUM TUBING

M. Perlman and J. F. Danovich 18 Oct. 1972 11 p refs
 (AD-752030; NADC-72201-VT) Avail: NTIS CSCL 11/3

The report describes the effects of liquid oxygen on chemically treated (chromic acid anodized and chromate conversion coated) surfaces of aluminum tubing used in aviators' breathing systems. Tests were conducted to detect residual deposits, gaseous contamination and changes in surface structure. Author (GRA)

N73-17676# Finnish Meteorological Inst., Helsinki.
AN INVESTIGATION INTO WIND SHEAR AT HELSINKI AIRPORT

Eero Immonen Jun. 1972 40 p refs
 (TR-3) Avail: NTIS HC \$4.25

Vertical wind shear measurements were made using a balloon rising with the average rate of 180 m/min and optical theodolites to measure the angle at 10 sec intervals and to check the rate of ascent. Weather permitting, soundings were carried out on three days of the week at four synoptic times from the beginning of April 1967 through March 1968. The annual, seasonal, and diurnal distributions are discussed and are graphed. N.E.N.

N73-17694# Sierra Research Corp., Boulder, Colo. Environmental Systems Group.

FIELD TEST OF WARM FOG DISPERSAL SYSTEM TO SUPPORT MARINE CORPS HELICOPTER OPERATIONS

Ralph Papania, Jr. 20 Jun. 1972 76 p refs
 (Contract M00264-72-C-0094)
 (AD-752046) Avail: NTIS CSCL 04/2

Warm fog dispersal techniques using helicopter downwash mixing and hygroscopic seeding were successfully tested to a limited degree on fog and low stratus. The equipment, procedures and nomograms for helicopter application of hygroscopic seeding materials are described as they were developed in three field tests. Weather conditions suitable for dispersal operations occurred on only one day, during which a useable clearing was created in low stratus, 650 feet thick. Results show that the effectiveness of fog dispersal by helicopter downwash was considerably enhanced when the fog or stratus layer was treated with hygroscopic seeding agent (unsized urea in these particular tests). Some quantitative data and photographic coverage is presented. Author (GRA)

N73-17708# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
AIRCRAFT TRANSITION ALGORITHM FOR CONFLICT PREDICTION, WITH SPECIFIC REFERENCE TO THE NORTH ATLANTIC AIR TRAFFIC CONTROL SYSTEM

D. J. Mohr Jan. 1973 131 p refs
 (UTIAS-TN-183) Avail: NTIS HC \$8.75

The development of digital fast-time air traffic control conflict prediction simulation models is discussed. A simulation algorithm was designed for compatibility with the Gander Automated Air Traffic System. The algorithm is applied to multiple aircraft strategically controlled environments and functions to search, detect, and resolve conflict situations during enroute aircraft transitioning. The simulation model includes meteorological data, route structure, flight trajectory construction, and a conflict resolution option. Author

N73-17710*# Kanner (Leo) Associates, Redwood City, Calif.
VISUAL CONSIDERATIONS CONCERNING APPROACH LIGHTS

N. Iwataki and H. Kansaku Washington NASA Jan. 1973 26 p refs Transl. into ENGLISH from Iijitsu Hokoku (Japan), v. 7, no. 2, Oct. 1966 p 98-107
 (Contract NASw-2481)

(NASA-TT-F-14667) Avail: NTIS HC \$3.50 CSCL 17G

Approach lights serve the pilot, landing at night or in bad weather, as visual aids to his spatial judgment. Desirable properties of approach lights such as color, intensity, configuration, etc., are discussed from the viewpoint of visual perception with data from published, fundamental research and investigations. The color red is most desirable as an approach light considering visibility in several weather conditions, darkness adaptation, advance-retreat and swelling-contracting phenomenon, ability to discriminate from other lights at the airfield, and transmissivity of light through the atmosphere. The optimal intensity of light is related to the color of the light and the amount of glare. Stroboscopic light is effective for increased conspicuousness. Visual approach slope line indicator systems and a few others were determined to be superior to other configurations. Author

N73-17803# Esso Research and Engineering Co., Linden, N.J. Government Research Lab.

FUEL MODIFICATION FOR ABATEMENT OF AIRCRAFT TURBINE ENGINE OXIDES OF NITROGEN EMISSIONS
 Final Report, 26 Apr. 1971 - 31 May 1972

Henry Shaw Oct. 1972 134 p refs
 (Contract F33615-71-C-1575; AF Proj. 3066)
 (AD-752581; GRU.1GDJA.72; AFAPL-TR-72-80) Avail: NTIS CSCL 21/4

The report describes a broad experimental program that was undertaken to assess the feasibility of reducing NO(x) from aircraft gas turbine engines by fuel modification. The Esso High Pressure Cannular Combustor was used to simulate the characteristic emissions of gas turbines at full power operation. Over 70 fuel modifications were tested using Jet A as the base fuel. Soluble compounds of cobalt, iron, magnesium, and copper reduce NO(x) by as much as 30% when added to the fuel at a treat rate of up to 0.5% (w). None of the investigated additives were fully acceptable because of the relatively low NO(x) reduction that was obtained even with high additive treat rates. A simple expression was derived which is useful in estimating NO levels in gas turbine combustors when equilibrium NO(x) concentrations and temperature are known. Author (GRA)

N73-17809*# AiResearch Mfg. Co., Torrance, Calif.
ANALYTICAL INVESTIGATION OF CHORD SIZE AND COOLING METHODS ON TURBINE BLADE COOLING REQUIREMENTS. BOOK 1: SECTIONS 1 THROUGH 8 AND APPENDICES A THROUGH I

F. E. Faulkner Aug. 1971 378 p refs
 (Contract NAS3-13205)

(NASA-CR-120882-Bk-1; AiResearch-71-7487-Bk-1) Avail: NTIS HC \$21.00 CSCL 21E

A study was conducted to determine the effect of chord size on air cooled turbine blades. In the preliminary design phase, eight turbine blade cooling configurations in 0.75-in., 1.0-in., and 1.5-in. chord sizes were analyzed to determine the maximum turbine inlet temperature capabilities. A pin fin convection cooled configuration and a film-impingement cooled configuration were selected for a final design analysis in which the maximum turbine inlet temperature was determined as a function of the cooling air inlet temperature and the turbine inlet total pressure for each of the three chord sizes. The cooling air flow requirements were also determined for a varying cooling air inlet temperature with a constant turbine inlet temperature. It was determined that allowable turbine inlet temperature increases with increasing chord for the convection cooled and transpiration cooled designs, however, the film-convection cooled designs did not have a significant change in turbine inlet temperature with chord. Author

N73-17810* AiResearch Mfg. Co., Torrance, Calif.
ANALYTICAL INVESTIGATION OF CHORD SIZE AND COOLING METHODS ON TURBINE BLADE COOLING REQUIREMENTS. BOOK 2: APPENDIXES J THROUGH M
 F. E. Faulkner Aug. 1971 334 p refs
 (Contract NAS3-13205)
 (NASA-CR-120882; AiResearch-71-7487-Bk-2) Avail: NTIS HC \$18.75 CSCL 21E

N73-17814* National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.
TWO-DIMENSIONAL CASCADE TEST OF A HIGHLY LOADED, LOW-SOLIDITY, TANDEM AIRFOIL TURBINE ROTOR BLADE
 John F. Kline and Roy G. Stabe Washington Mar. 1973 19 p refs
 (NASA-TM-X-2729; E-7216) Avail: NTIS HC \$3.00 CSCL 21E

A tip region section of a low-solidity tandem airfoil blade for a turbine rotor was tested in a two-dimensional cascade tunnel at solidities of 0.736 and 0.912. Blade surface static pressures and blade exit total and static pressure and flow angle were surveyed. Blade surface velocities, wake shapes, and kinetic energy losses were analyzed and compared with values for 1.852 solidity tandem airfoil blading. Author

N73-17815* National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF AERODYNAMIC PERFORMANCE OF COOLED TURBINE VANES AT GAS-TO COLLANT-TEMPERATURE RATIOS UP TO 2.75
 Roy G. Stabe and Robert P. Dengler Washington Mar. 1973 33 p refs
 (NASA-TM-X-2733; E-7183) Avail: NTIS HC \$3.00 CSCL 21E

The results of an experimental investigation of the aerodynamic performance of two geometrically similar turbine vanes with different cooling designs are presented. The test vanes were a convection-film-cooled vanes and a transpiration-cooled vane. A solid uncooled vane with the same aerodynamic profile as the cooled vane was also tested. Four vanes of each type were tested in an annular sector cascade. The cooled vanes were tested at primary to coolant temperature ratios of 1.0, 1.75, and 2.75 and a coolant to primary pressure ratios of 1.0, 1.2, and 1.5. This resulted in coolant flows up to about 10 percent of the primary flow. The principal measurements were surveys of vane exit total pressure, total temperature, and static pressure. The report includes a brief description of the test facility and the design of the test vanes. The test results presented include weight flow and efficiency data for the uncooled vanes and coolant flow, primary flow, and efficiency data as functions of the cooling variables for the cooled vanes. Author

N73-17817* National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.
PERFORMANCE COMPARISON OF THREE NORMAL-SHOCK POSITION SENSORS FOR MIXED-COMPRESSION INLETS
 Miles O. Dustin and Gary L. Cole Washington Mar. 1973 29 p refs
 (NASA-TM-X-2739; E-7197) Avail: NTIS HC \$3.00 CSCL 21E

The performance of three types of normal shock position sensors for supersonic inlets is described. All three sensors determined the shock position from the presence of the large pressure gradient at the normal shock location. The logic means for the three sensors were: (1) electronic, using pressure transducers, (2) fluidic, and (3) direct-coupled pressure switches. The sensors were evaluated in a two-dimensional, Mach 2.7, supersonic inlet having 30-percent internal supersonic area contraction. Both dynamic (from 1 to 80 Hz) and static tests were conducted. Author

N73-17822* Bendix Corp., South Bend, Ind. Energy Controls Div.
ULTRASONIC TRANSMISSION INVESTIGATIONS FOR TURBINE INLET GAS TEMPERATURE MEASUREMENT
 Final Report, Jan. 1971 - Jun. 1972
 C. J. Ahern, C. S. Longstreet, B. R. Teitelbaum, and W. E. Werts Sep. 1972 291 p refs
 (Contract F33615-71-C-1184; AF Proj. 3086)
 (AD-752602; ECD-863-18249-R; AFAPL-TR-72-75) Avail: NTIS CSCL 21/5

For advanced turbine engine propulsion systems, the need for an accurate, fast response turbine inlet gas temperature measurement is becoming more acute. One of the potentially promising techniques is the ultrasonic gas gap approach which utilizes the transit time of a high-frequency acoustic pulse to determine the average gas temperature along a path through the sound supporting medium. The objective of this Air Force sponsored research and development effort was to ascertain the potential and limitations of such an approach. Based on engine noise tests conducted on a J85-7 turbojet engine and both bench and burner rig evaluations of candidate transmission approaches, a matched piezoelectric transmitter/receiver pair operating in a gated RF mode within the carrier frequency range of 200 to 500 kHz was selected as a prototype engine sensor.

Author (GRA)

N73-17892* National Aeronautics and Space Administration.
 Washington, D.C.
THE NASTRAN PROGRAMMER'S MANUAL
 1972 2309 p
 (NASA-SP-223(01)) Avail: Computer Software Management and Information Center, Barrows Hall, University of Georgia, Athens, Georgia 30601 \$27.50 CSCL 20K

The computer programmer manual for NASTRAN is presented. The subjects discussed are: (1) NASTRAN programming fundamentals, (2) data block and table description, (3) subroutine descriptions, (4) module functional descriptions, (5) NASTRAN-operating systems interfaces, (6) modifications and additions to NASTRAN, and (7) NASTRAN support program. Author

N73-17900* Boeing Commercial Airplane Co., Seattle, Wash.
RESIDUAL STRESS ALLEVIATION OF AIRCRAFT METAL STRUCTURES REINFORCED WITH FILAMENTARY COMPOSITES Technical Report, Jul. 1971 - Mar. 1972
 J. B. Kelly and R. R. June Jan. 1973 95 p refs
 (Contract NAS1-8858)
 (NASA-CR-112207; D6-60136-4) Avail: NTIS HC \$6.75 CSCL 20K

Methods to eliminate or reduce residual stresses in aircraft metal structures reinforced by filamentary composites are discussed. Residual stress level reductions were achieved by modifying the manufacturing procedures used during adhesive bonding. The residual stress alleviation techniques involved various forms of mechanical constraint which were applied to the components during bonding. Nine methods were evaluated, covering a wide range in complexity. All methods investigated during the program affected the residual stress level. In general, residual stresses were reduced by 70 percent or more from the stress level produced by conventional adhesive bonding procedures. Author

N73-17916* Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
EFFECT OF FUEL ZONING AND FUEL NOZZLE DESIGN ON POLLUTION EMISSIONS AT GROUND IDLE CONDITIONS FOR A DOUBLE-ANNULAR RAM-INDUCTION COMBUSTOR Final Report
 T. R. Clements Feb. 1973 61 p refs
 (Contract NAS3-11159)
 (NASA-CR-121094; FR-5295) Avail: NTIS HC \$5.25 CSCL 21B

An exhaust emission survey was conducted on a double-annular ram induction combustor at simulated ground idle conditions. The combustor was designed for a large augmented

turbofan engine capable of sustained flight speeds up to Mach 3.0. The emission levels of total hydrocarbon (THC), carbon monoxide, carbon dioxide, and nitric oxide were measured. The effects of fuel zoning, fuel nozzle design, and operating conditions (inlet temperature and reference Mach number) on the level of these emissions were determined. At an overall combustor fuel/air ratio of 0.007, fuel zoning reduced THC emissions by a factor of 5 to 1. The reduction in THC emissions is attributed to the increase in local fuel/air ratio provided by the fuel zoning. An alternative method of increasing fuel/air ratio would be to operate with larger-than-normal compressor overboard bleed; however, analysis on this method indicated an increase in idle fuel consumption of 20 percent. The use of air-atomizing nozzles reduced the THC emissions by 2 to 1. Author

N73-17921*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

MEASUREMENT OF GASEOUS EMISSIONS FROM AN AFTERBURNING TURBOJET ENGINE AT SIMULATED ALTITUDE CONDITIONS

Larry A. Diehl Washington Mar. 1973 20 p refs
(NASA-TM-X-2726; E-7238) Avail: NTIS HC \$3.00 CSCL 21B

Gaseous emissions from a J85-GE-13 turbojet engine were measured over a range of fuel-air ratios from idle to full afterburning and simulated altitudes from near sea-level to 12,800 meters (42,000 ft). Without afterburning, carbon monoxide and unburned hydrocarbon emissions were highest at idle and lowest at takeoff; oxides of nitrogen exhibited the reverse trend. With afterburning, carbon monoxide and unburned hydrocarbon emissions were greater than for military power. Carbon monoxide emissions were altitude dependent. Oxides of nitrogen emissions were less at minimum afterburning than at military power. For power levels above minimum afterburning, the oxides of nitrogen emissions were both power level and altitude dependent.

Author

N73-17991*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

NORTHWEST PASSAGE: TRADE ROUTE FOR LARGE AIR CUSHION VEHICLES

John L. Anderson Washington Mar. 1973 38 p refs
(NASA-TM-X-2684; E-7211) Avail: NTIS HC \$3.00 CSCL 01C

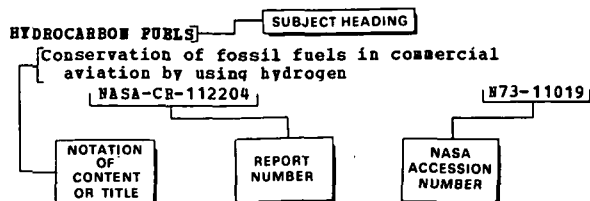
A conceptual vehicle and powerplant (10,000-ton) nuclear-powered air-cushion vehicle (ACV) that could open the Northwest Passage and other Arctic passages to commercial traffic is identified. The report contains a description of the conceptual vehicle, including the powerplant and operations, an assessment of technical feasibility, estimates of capital and operating costs, and identification of eligible cargo and markets. A comparison of the nuclear ACV freighter with nuclear container ships shows that for containerized or roll-on/roll-off cargo the ACV would provide greatly reduced transit time between North Atlantic and North Pacific ports at a competitive cost. Author

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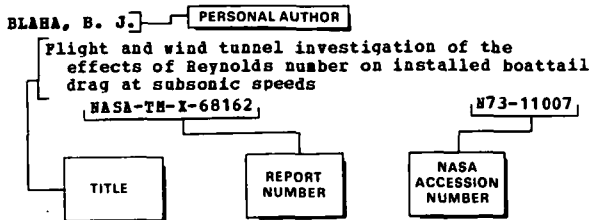
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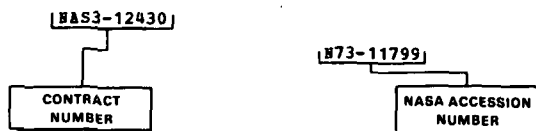
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